THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR: George H. Buck

TITLE OF THESIS: A Technological History of Municipally Owned Public Transportation in Edmonton, 1893-1981

DEGREE FOR WHICH THESIS WAS PRESENTED: Master of Education

YEAR THIS DEGREE GRANTED: 1985

THE UNIVERSITY OF ALBERTA

A Technological History of Municipally Owned Public Transportation in Edmonton, 1893-1981

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

Master of Education in Industrial Arts Education

DEPARTMENT OF INDUSTRIAL AND VOCATIONAL EDUCATION

EDMONTON, ALBERTA

Spring, 1985

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A Technological History of Municipally Owned Public Transportation in Edmonton, 1893-1981

submitted by George H. Buck

in partial fulfillment of the requirements for the degree of

Master of Education

Dedication

I wish to dedicate this thesis to the memory of Dr. Henry R. Ziel who was the first Chairman of the Department of Industrial and Vocational Education at the University of Alberta, and who encouraged me in my effort to explore a new area of educational research: technological history.

> Youngsters should be permitted an exploratory environment that is not confined to woods, metals, drafting or similar craft oriented interpretations of our productive society . . . they must recognize the impact of the various technologies, materials, processes and man technology confrontations. (Ziel, 1971, pp. 5-6)

Abstract

This thesis chronicles the origins and the technological development of municipally-owned public transportation in Edmonton from 1893 through the early 1980's. The transportation modes such as street railways, buses and Light Rail Transit are divided into categories and are described and analyzed in a chronological fashion. The necessary plant as well as the various types of rolling stock and their required ancillary systems are also divided into categories and are described and analyzed in considerable detail. Figures, plates and maps are employed to supplement descriptions and observations concerning construction, rolling stock and installations.

Modifications to equipment and the plant are noted and described, with particular emphasis placed upon descriptions and explanations of modifications to plant and rolling stock brought about by local factors peculiar to Edmonton. In addition to a complete textual description of rolling stock, an extensive listing of all the major features of each unit of rolling stock is provided to facilitate clarity and comparisons.

Apparent trends in technological development are included as well as suggested applications for the content to educators, transit personnel, historians and individuals or groups engaged in restoration or preservation work.

Acknowledgments

The author of this thesis is obliged to the following individuals and organizations that provided technical information included in the development of the content of the report: the late Mr. R. Addley, AEC/ Leyland Vehicles Limited, Ahearn and Soper, Allis-Chalmers Company, Mr. G. Benson, Canadian General Electric Company, City Clerk's Office, City of Edmonton Archives, Mr. R. R. Clark, Edmonton Power, Edmonton Radial Railway Society, Edmonton Transit, General Motors of Canada Limited, Greenfield Village and Henry Ford Museum, Mr. R. Greenham, Mr. J. Guay, Mr. C. K. Hatcher, Historical Society of Pennsylvania, Mr. L. S. Kozma, Mr. J. E. Lanigan, Mr. D. L. MacDonald, Mack Truck Company, Dr. D. V. Parker, Mr. T. Schwarzkopf, St. Louis Car Company, and Mr. L. F. Wiebe.

The following responded to the author's request for special resource material, information and assistance required to develop the manuscript of this report: Mrs. G. Baird, Mrs. H. V. Buck, Dr. R. J. Buck, Ms. Z. E. Buck, Dr. I. A. Campbell, the staff of the City of Edmonton Archives, Mr. L. S. Corness, Mr. N. F. Corness, Mr. P. A. Cox, Mr. S. Diachuk, Mr. R. Farrants, Mr. C. K. Hatcher, Mr. H. Hollingworth, Mr. G. D. Kendal, Mr. J. E. Lanigan, Mr. M. J. McIntyre, Miss T. Orn, Mr. C. F. Redge, Mr. E. M. Smith, Society for the Retired and Semi-Retired, Mr. A. Theoret, Mr. R. J. Walker, Dr. E. G. Wilson, Miss B. E. Wright, and the late Dr. H. R. Ziel.

A special acknowledgment is made to the members of the examining committee who took time from their professional and teaching responsibilities to review this thesis. The members were: Dr. J. A. Kernahan, Dr. D. V. Parker, and Dr. C. H. Preitz, thesis supervisor.

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LIST OF ABBREVIATIONS WITHIN TEXT AND APPENDIX I

AC	Allis Chalmers
A.C.	Alternating Current
ACF	American Car and Foundry
AEC	Associated Equipment Company
ALCO	American Locomotive Company
ASCE	American Society of Civil Engineers
BRC	Board of Railway Commissioners
B.C.	British Columbia
BBC	Brown Boveri Company
B Boveri	Brown Boveri Company
CCF	Canadian Car and Foundry
CEAR	City of Edmonton Annual Report
CECR	City of Edmonton Commissioners' Report
CEED	City of Edmonton Engineers' Department
CGE	Canadian General Electric
CEUCR	City of Edmonton Utilities Commissioners' Report
CNR	Canadian National Railways
CNoR	Canadian Northern Railway
CPR	Canadian Pacific Railway
D.C.	Direct Current
DE	Double End
Duewag	Waggonfabrik Uerdingen
EE	English Electric
EIR	Edmonton Interurban Railway
EL&PD	Electric Light and Power Department

EL&PDAR	Electric Light and Power Department Annual Report
EPAR	Edmonton Power Annual Report
ERR	Edmonton Radial Railway
ET	Edmonton Transit
ETAR	Edmonton Transit Annual Report
ETS	Edmonton Transit or Transportation System
ETSAR	Edmonton Transit System Annual Report
ETSMR	Edmonton Transit System Monthly Report
EY&PR	Edmonton Yukon and Pacific Railway
FE-CE	Front Entrance - Centre Exit
FIL	Flyer Industries Limited
FTC	Fageol Twin Coach
GE	General Electric (United States)
GEC	General Electric Company (Britain)
GMC	General Motors Coach
GTP	Grand Trunk Pacific
h	Hour
H.P.	Horse Power
kg	Kilogram
km	Kilometre
K&M	Kummler and Matter
kN	Kilonewton
kPa	Kilopascal
kW	Kilowatt
Lbs.	Pounds
LRT	Light Rail Transit
m	Metre

McG-C	McGuire-Cummings
MCB	Master Car Builders
mm	Millimetre
MRC	Magnetic Remote Control
MU	Multiple Unit Operation
N/A	Not Applicable
NAR	Northern Alberta Railways
N.B.	New Brunswick
OCC	Ottawa Car Company
OCM	Ottawa Car Manufacturing Company
PAYE	Pay As You Enter
PC&C	Preston Car and Coach Company
PDAR	Power Department Annual Report
SE	Single End
SI	Système International d'Unités
SRD	Street Railway Department
SRDAR	Street Railway Department Annual Report
SRDGL	Street Railway Department General Ledger
SRDMR	Street Railway Department Monthly Report
SRDNMR	Street Railway Department Nine Months Report
SRDPTR	Street Railway Department Permanent Track Report
TDH	Transit Diesel Hydraulic
TTC	Toronto Transit or Transportation Commission
T&YRR	Toronto and York Radial Railway
U.L.	Underwriters' Laboratory
WFC	Western Flyer Company
WH	Westinghouse

Chapter I

The Problem

Introduction

The construcltion of a municipally-owned public transportation system in Edmonton began in the year 1907. Since its inception as the Edmonton Radial Railway in 1908, the Edmonton Transit System (now known as Edmonton Transit) has undergone many changes in plant, equipment and maintenance procedures. Most of these changes were brought about through circumstances such as: improvements in the general technology available; need for greater safety; economic conditions; failure of materials or systems in operation. Some of the changes implemented did improve the efficiency and the operation of the system, while other changes either hindered it or had no effect. A work that describes and analyzes these changes could be beneficial to those people who have an interest in teaching the development of various technologies that are found, or that have been found, in twentieth-century North American society.

Some authors, such as Campbell (1978) and Hatcher and Schwarzkopf (1983), have written works which describe the development of the Edmonton Radial Railway/Edmonton Transit. These works, however, are primarily concerned with the social aspects and personal anecdotes associated with the Edmonton Radial Railway/Edmonton Transit. Although a limited number of technical aspects of the system are mentioned by these writers, they are often incomplete and inaccurate. These authors, as well as others who have written about the system, have obtained their data mainly from secondary sources, personal recollections, employees and former employees. While the occasional reference is made by these authors to a primary source, no evidence exists that shows that these

writers have based their works on information gathered from primary sources.

The need for rigorous, scholarly and objective research which deals specifically with the history of the Edmonton Radial Railway/Edmonton Transit, from the viewpoint of technological change and development, can be seen for the following reasons: no work yet exists which accurately and fully describes the technical aspects of all the roiling stock and related plant from 1907 to 1980; no work exists which attempts to explain the reasons why changes to rolling stock, plant and maintenance procedures came about; no work yet exists which enables the reader to trace the technological changes and developments in the Edmonton Radial Railway/Edmonton Transit from 1907 to 1980.

Statement of the Problem

The purpose of this technological history was to describe: the factors which determined the technologies used by the Edmonton Radial Railway/Edmonton Transit; how these technologies changed and developed between 1907 and 1980; and the reasons why these changes and developments occurred.

Major Objective

The major objective of this technological history was to provide an accurate, complete and chronological account of the development and changes to the physical plant and equipment used by the Edmonton Radial Railway/Edmonton Transit from 1907 to the end of 1980.

Objective

The major objective was realized with aid from the following support-

ing objectives.

- To describe the methods and materials used in the construction and maintenance of the: roadbed, track, electrical generation and electrical distribution systems of the Edmonton Radial Railway/Edmonton Transit in the time frame established for the research (1907 - 1980).

- To describe the construction, operating principles and modifications to each type of rolling stock (passenger and freight) from the time that it was either purchased or built, to the time that it was disposed of, or to the end of 1980.

- To compile a roster of all rolling stock used between the years 1908 and 1980. The roster will include: name of manufacturer(s), vehicle model or designation, serial numbers (if any), year(s) of manufacture, year of delivery, condition of delivery, distinguishing characteristics, major dimensions, type of body construction, type of frame or chassis construction, types of brakes, types of trucks (for rail vehicles only), number and type of motor or engine, gear ratios or type of transmission, type of electrical control (electric vehicles only), year withdrawn from service, year disposed of, final disposition (if known).

- To describe the reasons why each particular design or type of vehicle was selected and to describe why some designs were superseded by others.

- To describe the various operational and environmental factors peculiar to Edmonton which contributed to the type of rolling stock and plant selected and which contributed to the modifications and changes to the rolling stock and related plant.

Significance of the Study

Industrial Arts is a subject area that is not characterized by teaching

and research in only one particular area of technology. The study of the technology of transportation is, therefore, of considerable importance. The movement of goods and people has been, and is, extremely important to the successful functioning of any industrial society. H. R. Ziel (1971) said of power systems and their related technologies, "They are increasingly becoming more dominant in our daily productive lives and in our leisure activities. Therefore, power and its systems as a unique technology become a viable area of study for industrial arts" (p. 76). The importance of the historical aspects of power and transportation technology have been emphasized recently. In The Technology Teacher, a periodical of the American Industrial Arts Association (February 1984), the article entitled "Resources in Technology" contains a section which describes, briefly, the history of transportation. (pp. 23-26) Where twentieth-century land transportation is described, however, only American developments and applications are mentioned. No consideration is given to environmental factors nor to developments in transportation technologies that are unique to Canada. This technological history provides information that was previously lacking on aspects of Canadian transportation technology in one of Canada's major cities.

Both the junior high school and the senior high school curriculum guides for industrial education (industrial arts) include either a field of study called "Power Technology", or the career field of "Power". Power Technology is taught at the junior high school level and as a field of study is comprised of four modules. One of these modules is Power Mechanics. Power is one of the four career fields taught at the senior high school level and consists of thirteen modules. An in-depth critical analysis of these curriculum guides shows that the development of the learning activities are factors that influence technological change in all

transportation systems.

This technological history will enable individual industrial arts teachers, as well as curriculum planners, to design units of instruction and study concerned with: power transmission, development of power systems, factors that have influenced technological change, the operation of large electrically powered vehicles, the operation of propane, diesel and gasoline powered vehicles.

Since, at the time of writing, no other study of a similar nature exists at this institution, this technological history may be used by other scholars and by other institutions as a research model. The study may also be useful to those individuals who plan and who implement changes to the plant and equipment of Edmonton Transit. Above all, this technological history may have uses and applications that will become apparent in the future.

Limitations of the Research

The study had the following limitations imposed upon it.

It was limited to describing the technical history of the public transportation system of Edmonton, from its beginnings in 1906, through the end of 1980. References to other transportation systems were made only to provide background and clarity.

It was limited to descriptions and analyses of technical installations and technical developments. References to: routes, routing, scheduling, fares, fare collection, personnel, and other individuals, was made only to provide clarity.

The completeness of the study was limited by the amount of primary source material, including photographs, manufacturers' records and data,

and archival records that were available to the researcher.

The precision of the study was limited by the accuracy of the primary sources and the archival records and photographs used.

Major Assumption

The major assumption of this study was that the information contained in available primary sources was accurate. Van Dalen (1962) stated that, "Printed and written materials are not necessarily accurate. Sometimes clerks make errors in recording information; . . .official records are altered or slanted to give a better picture of conditions than actually exists" (p. 194). It was assumed, however, that the available primary sources were accurate unless evidence to the contrary was discovered or provided.

Methodology

In this study, data and information were gathered mainly from the following primary sources: manufacturers' records and specifications, equipment and construction contracts, City Commissioners' Reports, Street Railway Department Monthly Reports, Street Railway Department Annual Reports, correspondence between manufacturers and Street Railway officials or City Commissioners, Street Railway Departmental records, photographs, actual equipment and installations, shop foremen's log books, and historical technical books.

Where specific information considered necessary to this study did not exist in these primary sources, an attempt was made to locate the information in secondary sources such as transportation journals and newspapers. At no time in this study were contemporary accounts or anecdotal accounts used.

CHAPTER II

Background and Origins

Introduction

Edmonton, which is located adjacent to the North Saskatchewan River at approximately 53°29' North latitude and 113°49' longitude West of Greenwich (Lowe's Directory of the Edmonton District, 1899, p. 3) has been, since it was a Hudson's Bay Company fort in the early nineteenth century, an important location for transportation, trade and settlement. Technological improvements and conveniences were introduced as Edmonton grew in the late nineteenth century. A private electric light system and plant began operating in this centre in 1891. (Government of Canada, Department of the Interior, Water Resources Paper No. 33, 1922, p. 33) This operation began before Edmonton was an incorporated town. The population of Edmonton in 1890 was approximately 300 people. (City of Edmonton Statistical Records) Edmonton became a town in 1892. (Ordinances of the North-West Territories, 1891-1892, No. 7, p. 13)

Initial Legislation

The origins of the street railway in Edmonton began in 1893 when the Territorial Government empowered, "The Municipality of the Town of Edmonton to construct and operate a tramway" (Ordinances of the North-West Territories, 1893, No. 32, p. 277). This Ordinance authorized the Town, not a company, "to construct, maintain, equip and operate . . . a single or double track [i.e., one or two sets of tracks] tramway . . . along any of the streets of the Town and upon any lands therein

acquired for the purpose" (Ordinances of the North-West Territories, 1893, No. 32, p. 278). The Ordinance continued by stating that the lines of the tramway could travel beyond the Town limits, as those limits existed in 1893, up to a distance of 5 miles (8.05 km). The Ordinance also allowed the tramway to connect with the Calgary and Edmonton Railway near its northern terminus. In 1893 the terminus of the railway was located on the south side of the North Saskatchewan River in what was then called South Edmonton. South Edmonton later became the Town of Strathcona in 1899. (Ordinances of the North-West Territories, 1899, Chapter 28) Edmonton was not allowed, however, to construct a bridge across the North Saskatchewan River. The tramway was to be transported by river ferry in the warm months and could traverse the river during winter months by means of a track laid across the ice. (Ordinances of the North-West Territories, 1893, No. 32, p. 279) No bridge across the river at Edmonton had yet been built.

The tramway was permitted to transport both freight and passengers. The motive power of the tramway could be provided by animals, electricity, or any other form of power except steam. Electricity appears to have been the preferred means of power as the Ordinance describes the various pieces of equipment that the town could erect and construct for the production and distribution of electricity for the tramway. (Ordinances of the North-West Territories, 1893, No. 32, p. 279) Burch (1911) indicates that by 1893, electric street railways had proven to be more efficient and cheaper to operate than street railways using horses or mules. In addition, several Canadian cities such as Victoria, Toronto and Winnipeg were successfully operating electric street railways by 1893. (pp. 2-11)

Funding for the tramway could be borrowed or could be obtained

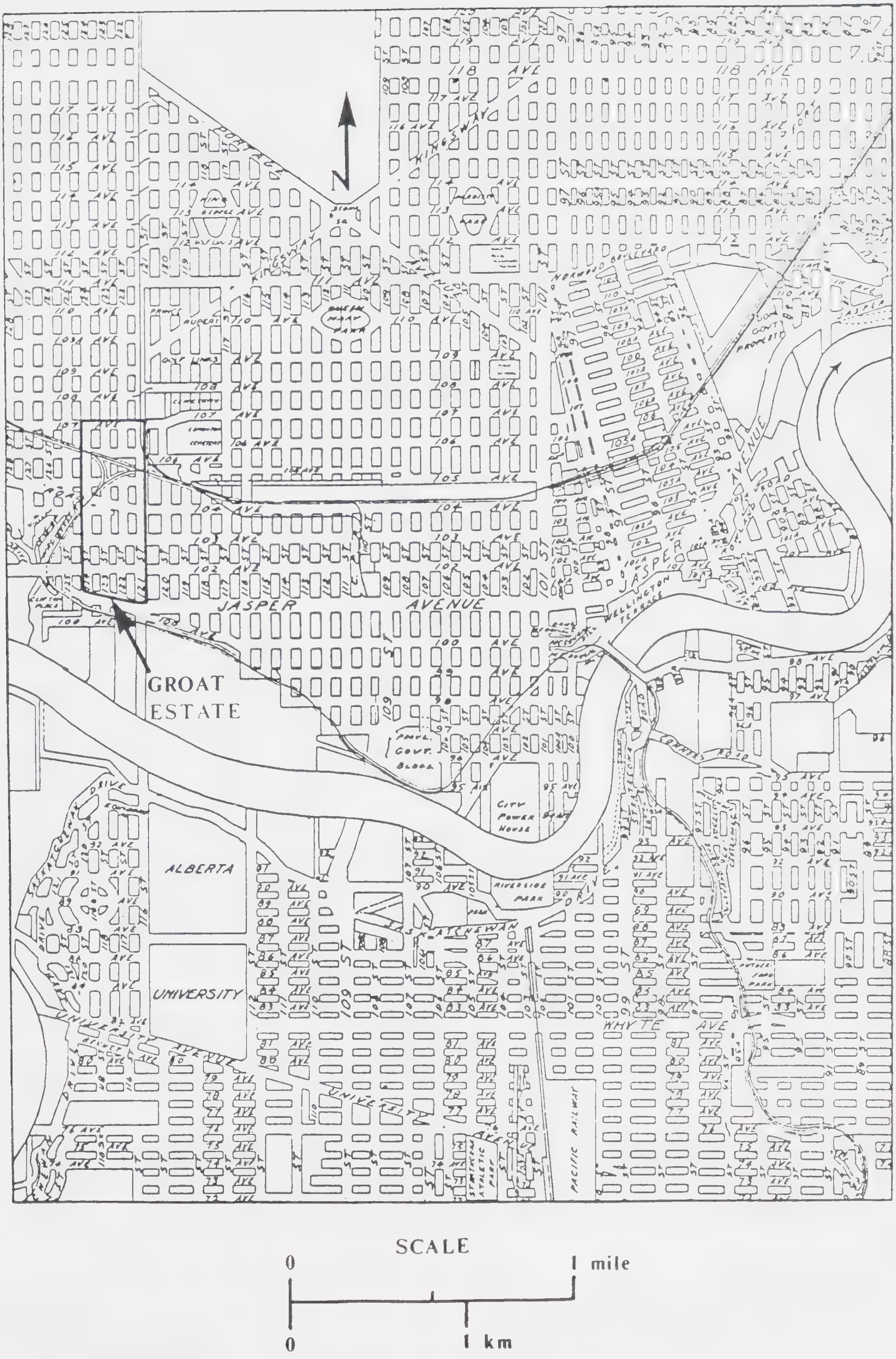
by issuing debentures, bonds and other securities subject to by-laws. (Ordinances of the North-West Territories, 1893, No. 32, pp. 280-281) The Town of Edmonton was also authorized, when supported by its ratepayers, to enter into agreements with private companies who would construct or operate the tramway, provided that the agreement would last no longer than twenty years. In any event, the town would ultimately control the tramway. The guidelines listed in the 1893 Ordinance were unusual insofar as it appears that most other Canadian and American street railways were constructed, owned and operated by private companies.

Construction by Private Company

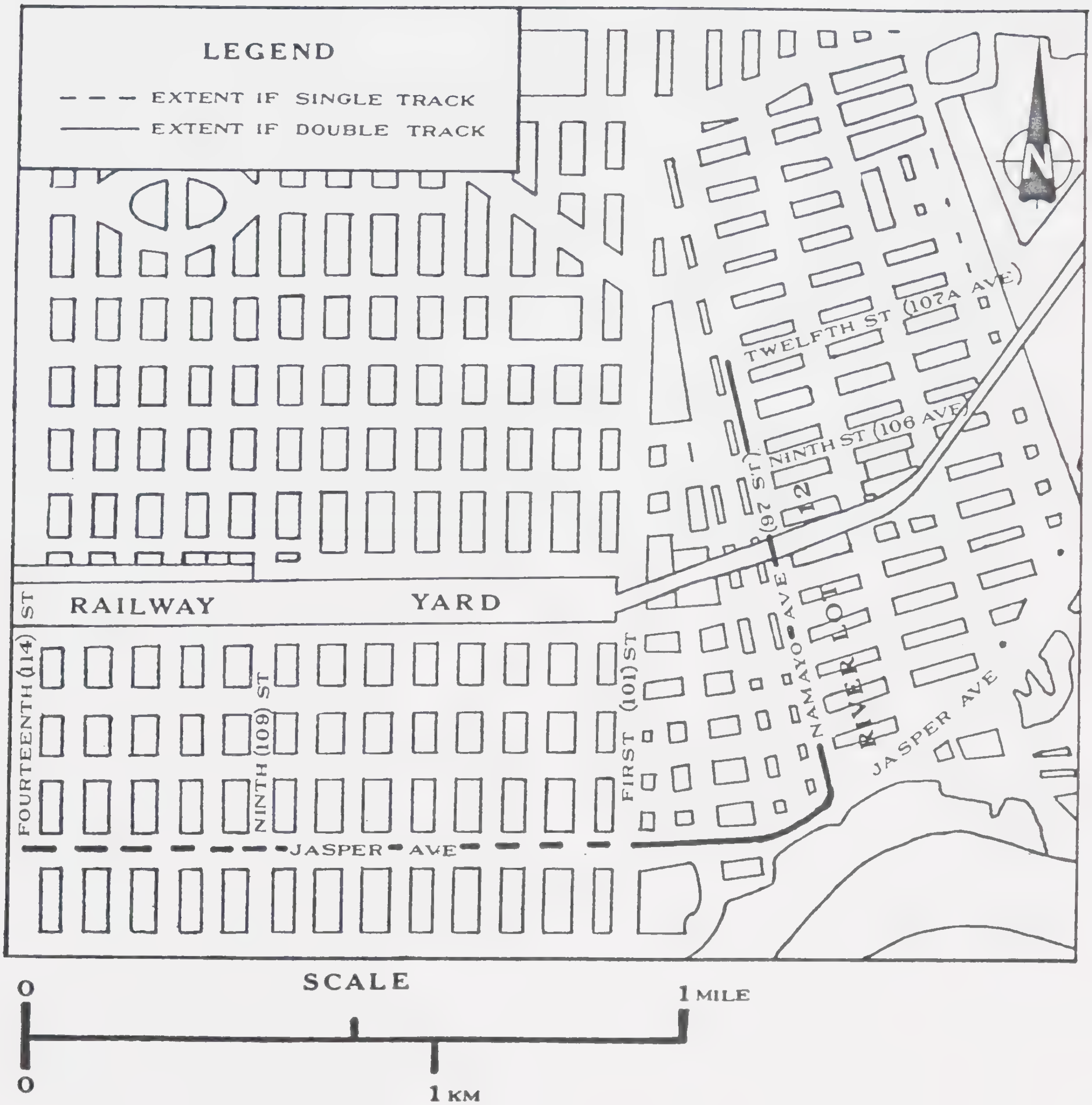
No definite action was taken in Edmonton to construct a tramway before 1904. In February of that year, a proposal for the construction and operation of a private electric street railway was submitted to the Town Council. (Edmonton Evening Journal, 1904, February 20, pp. 3-4) The proposal was made by the Edmonton Street Railway Company, its provisional directors, and Mr. William G. Tretheway who was a real estate agent then working in Edmonton. The proposal was found to be in need of revision and a revised version of it was submitted to the Town Council in March 1904. On March 10, the ratepayers of Edmonton voted on this proposal. The vote was in favor of the Town accepting the terms as described. (Edmonton Evening Journal, 1904, March 23, p. 4) There was not, however, total acceptance of the proposal among members of the Town Council. Mayor William Short vacated his chair before the Council voted and later refused to sign the Agreement after the Council had given its approval. Councilor May, acting on behalf of the Mayor, signed the Agreement. A press report (Edmonton Evening

Journal, 1904, March 23, p. 4), stated that Mayor Short felt that the Agreement did not comply with the terms of the 1893 Ordinance. The Mayor further felt that by allowing the Edmonton Street Railway Company to generate its own electricity, the Town would be deprived of revenue it otherwise would have received if it were to supply the power for the street railway.

The terms of the Agreement stipulated that the Edmonton Street Railway Company was to commence construction by June 1904 of at least 2 miles (3.2 km) of track within the Town limits. The track was to be laid along Namayo Avenue (97th Street) from Jasper Avenue north to 12th Street in River Lot 12 (later McCauley Street, now 107A Avenue), and west along Jasper Avenue to complete the required 2 miles (3.2 km). (Memorandum of Agreement [revised], 1904, p. 4) The route just described differs slightly from the route described in the initial proposal. In the unrevised version of the proposal, the line on Namayo Avenue (97th Street) was to be built only as far as 9th Street (later Sutherland Street, now 106th Avenue). (Edmonton Evening Journal, 1904, February 20, p. 3) Neither the initial proposal nor the Agreement state whether the line to be constructed was to be single-track or double-track. Map 2 (after Official Map of the City of Edmonton, 1938 and Mundy's Street Index Map of Edmonton, 1915) illustrates the route described in the Memorandum of Agreement. Two western termini are indicated, one for the extent of a single-track line, the other for the extent of a double-track line. A penalty clause required that the sum of $10,000.00 be entrusted to the Town by the Edmonton Street Railway Company. If streetcars were not actually operating on the specified 2 miles (3.2 km) of track by September 1, 1905, the Street Railway Company would forfeit both the deposit and all rights and privileges covered in the



MAP 1. LOCATION OF GROAT ESTATE



MAP 2. MARCH 1904 PROPOSED ROUTE

EDMONTON STREET RAILWAY COMPANY

Agreement. (Memorandum of Agreement [revised], 1904, p. 11) This penalty clause was the largest change made between the unrevised and the revised versions of the proposal, but there were other changes as well. In the initial proposal, a deposit of $25,000.00 was to be made to the Town by the Street Railway Company. For each year that the 2 mile (3.2 km) line remained incomplete the Company would forfeit only $5,000.00, less the accrued interest. This situation could continue for as long as five years, at which time the remainder of the deposit would be forfeit and the Agreement would become null and void. (Edmonton Evening Journal, 1904, February 20, p. 4)

Motive power and technical matters were covered extensively in the Agreement. The Company was to use the standard railway gauge of 4 feet 8½ inches (1 435 mm) with T-section rails of a weight of at least 40 pounds per yard (29.76 kg/m). The streetcars were to be electrically powered and were to have enclosed vestibules and warning bells or gongs. Power distribution was to be by means of a wire strung parallel with the rails at a designated height above the mid-point between the rails. The return current was to travel through "proper conductors", such as the rails and was not to travel through water mains. (Memorandum of Agreement [revised], 1904, pp. 5-7) If current travelled from a cast iron water pipe to a buried copper cable, for example, the action known as electrolysis would take place. Doane and Parkham (1926) state that, "whenever electricity flows from a metal conductor into damp earth, the conductor is eaten away, provided that the drop in voltage between the conductor and the adjacent earth is sufficient to effect the chemical decomposition" (§ 20 p. 41). Electrolysis was a major problem with other electric street railways and it was, as will be seen later, a chronic problem of the municipally-owned Edmonton Radial Railway.

The Memorandum of Agreement of 1904 reflected some of the technological improvements in the street railway industry since the Ordinance of 1893. Horse-powered vehicles were no longer considered and definite standards for construction and safety were introduced.

The change of the penalty clauses between the initial proposal and the Agreement, coupled with Mayor Short's apprehension, were indications that some felt that the Edmonton Street Railway would never operate a streetcar. A press report of June 1, 1904 seemed to refute this view. It stated that the Edmonton Street Railway Company was saving its deposit, as a contractor was hauling and piling gravel along Namayo Avenue (97th Street). (Edmonton Evening Journal, p. 5) In the same edition of the newspaper a large advertisement appeared that was worthy of note. It read, "BUY NOW. The Deposit of $10,000 has been made with the City [incorrect, as Edmonton was a town until October 1904. (Ordinances of the North-West Territories, 1904, Chapter 19)] and Street Railway Construction begins June 1. The Groat Estate is rapidly becoming an important part of Edmonton" (p. 4). The agent for this land development was a T. A. Stephen who, coincidentally, was also a director of the Edmonton Street Railway Company (see map 1 for the location of Groat Estate). (Edmonton Evening Journal, 1904, March 25, p. 1) It would appear that a street railway, or a promise of one, encouraged people to move to areas that were not close to the Town centre. It is also possible that Tretheway and the directors of the Edmonton Street Railway Company never had any intention of completing their street railway. It may be said that their main reason for agreeing to build one was to sell their lots in Groat Estate by any means possible.

By the end of August 1905, it was apparent that the Edmonton Street Railway Company would cease to exist. No construction had taken

place, the piles of gravel were still sitting on Namayo Avenue, and no equipment had been purchased. (Edmonton Daily Bulletin, 1905, August 22, p. 1) On September 1, the deposit became the property of City (a city since October 1904), the Agreement between the Edmonton Street Railway Company and the Town of Edmonton became null and void, and City crews began spreading the abandoned gravel along Namayo Avenue. (Edmonton Daily Bulletin, 1905, September 5, p. 8) The first attempt at constructing a street railway in Edmonton was a dismal failure. Since a private company was responsible for the failure, an attitude of skepticism towards similar proposals from private companies prevailed in Edmonton for some time. Events that had been occurring in Strathcona, Edmonton's rival on the south side of the North Saskatchewan River, would further encourage the City of Edmonton to build its own street railway.

Strathcona Radial Tramway Company

During 1904, the Government of the North-West Territories incorporated a private company known as the Strathcona Radial Tramway Company Limited. (Ordinances of the North-West Territories, 1904, Chapter 34, p. 255) The Ordinance specified that individuals, not the Town of Strathcona, were responsible for the construction and operation of the street railway. There were, however, several provisos. If the Company wished to construct and operate lines in Strathcona, or in any other municipality, the Company would have to obtain permission from the municipality concerned. The Company had three years to construct at least 15 miles (24.14 km) of track before the powers granted by the Ordinance ceased. (Ordinances of the North-West Territories, 1904, Chapter 34, p. 256)

Municipal Street Railway in Edmonton

In 1906 the Strathcona Radial Tramway Company submitted a proposal to the City of Edmonton asking for a franchise to enable the Company to construct and operate a street railway system in Edmonton in conjunction with an interurban line to Strathcona. (The Railway and Marine World, 1906, November, p. 675) The Edmonton City Council decided that a proposal from the City Engineer regarding a municipally-built system should also be considered. On October 25, 1906, Edmonton City Council decided against granting a franchise to the Strathcona Radial Tramway Company. (The Railway and Marine World, 1906, December, p. 753) By November 1906, Edmonton City Council had instructed the City Engineer to prepare an estimate for the cost and construction of a street railway system. (The Railway and Marine World, 1906, November, p. 675) The Engineer's proposal called for the construction of a total of 7.5 miles (12 km) of track. Three miles (4.8 km) were to be single-track construction and the remainder was to be double-track construction. The estimate included detailed specifications such as those for track construction. The total cost of construction was estimated to be $100,700.00. (The Railway and Marine World, 1906, December, p. 753) From this estimate, the City Council decided that a municipally-owned street railway was feasible.

Early in 1907, the City of Edmonton Commissioners placed an order for 470 tons (477 520 kg) of 80 pound per yard (33.2 kg/m) T-section rails, for delivery in March. (The Railway and Marine World, 1907, February, p. 111) A municipally-built street railway in Edmonton was started.

Review of Related Literature

Apart from primary source materials and press reports of the time, there are only a few modern works that deal either with the technical aspects or with the history of the Edmonton Radial Railway/Edmonton Transit (ERR/ET). Most of the works that were available presented brief, and often unsupported, anecdotal accounts of specific humorous or seemingly important events in the ERR's/ET's history. Such works were of no consequence or concern to this study. A small number of works, however, did attempt to provide accurate accounts of the history of the ERR/ET. It is with these works that this section is concerned.

The first, written and published by the staff of the Edmonton Transit System (ETS, now ET) during 1966, is entitled Edmonton Transit System Condensed History of Events, 1908 to 1966. This work, which is only 19 pages in length, contains several photographs and maps and lists significant events and their dates. Equipment listings are also provided but the pamphlet does not deal with the technical aspects of construction or operation of the ERR. No sources for the material are cited. While some of the information in the pamphlet can be substantiated by consulting various primary sources, much of the information is inaccurate and unsupported. In some instances, subsequent works have used the pamphlet as source material. Several errors that appear in the pamphlet have, therefore, been perpetuated. One example of this can be found on pages 1 and 14. It is stated that the external color scheme applied to the streetcars purchased in 1908 consisted of two tones of brown. The error is that the color scheme did not use any shade of brown at all. A press report of October 29, 1908 stated that the streetcars were painted green, with natural wood trim and gold letters. (Edmonton Bulletin, p. 8) In

addition to the press report, contracts for subsequent orders of streetcars describe the paint scheme as a combination of green and red; the green being applied below the windows, the red being applied above the windows to the roof, which was painted black. (Ottawa Car Company Contracts for streetcars, November 1909, October 1910, December 1910) In addition to presenting some erroneous and unsupported information, the pamphlet excludes many important technical matters. At no point, for example, does the pamphlet explain that many of the streetcars were originally constructed as double-end (could be operated from either end) vehicles and that most were later reconstructed to single-end operation.

While the pamphlet provides the reader with a cursory history of the ERR/ETS, it cannot be considered a serious work.

The next relevant work to appear was a privately-published book by E. E. B. Campbell (1978) Edmonton Transit System Story, 1903-1978. This work was the first extensive account of the history of the ERR/ET. Most of the information contained in the book was obtained from two sources, the 1966 ETS pamphlet and press reports from the Edmonton Journal and Edmonton Bulletin newspapers. The author, however, claimed that her information was, "gleaned from every possible available source and verified" (p. ii). Her claim does not appear to be true because many, if not most, parts of her account are unsubstantiated. One example may be found in her description of the events leading to the formation of the ERR. She describes the history of an earlier venture, the Edmonton Street Railway Company. Although the company failed to construct a street railway, she claimed that, "by September 1905, tracks were actually laid --- [sic.] at least two miles" (p. 9) No source for this statement is cited and an investigation of the press reports of the time reveal that the only construction that took place was the deposition of

several mounds of gravel along Namayo Avenue (97th Street). (Edmonton Journal, September 5, 1905, p. 8) Campbell also perpetuated the error in the pamphlet about the original streetcar color scheme. Like the ETS pamphlet, Campbell's book tends to avoid descriptions and explanations of technical matters. While there are many discrepancies and errors in the work, it would serve no purpose to cite further examples.

Campbell's book is, clearly, a labor of love which contains some valuable information. The work, however, cannot be considered a suitable source for research because the frequent errors and erratic documentation make it unreliable.

The June 1980 issue of Canadian Rail contained an article on the history of Edmonton's streetcars. The article, Edmonton Streetcars, 1908 to 1979, was written by L. Marsh. Marsh's article, like the ETS pamphlet, is short and did not cite any sources. Although Marsh's article contains more information about technical matters than previous works, much of the information presented is inaccurate or incomplete. An example may be found on page 164 where the author states, "There was no heat in the early streetcars, nor were there any storm windows . . .". The contracts for the first seven streetcars indicate clearly that 14 electric cross-seat heaters (10 in the case of streetcar 7 which was smaller than numbers 1 to 6) were to be installed in each streetcar. (Ottawa Car Company Contracts for streetcars, September 1908) In addition, the same document also states that all side windows were to be fitted with storm sashes. Further proof of the existence of the storm sashes may be found on a photograph that was included in the article. (p. 166) The Provincial Archives of Alberta photograph depicts streetcar number 2 on an Edmonton street on October 29, 1908. A visual comparison of the side and end windows reveal that the side windows did possess storm

sashes. Marsh also perpetuated the color scheme error that had been started by the 1966 ETS pamphlet. (p. 166)

Although the article in Canadian Rail contains unsupported material, it served a purpose by informing a large number of readers of the existence and the basic development of the ERR.

In 1983, Railfare Enterprises published a book that dealt exclusively with the history of electrically-powered public transportation vehicles in Edmonton. Edmonton's Electric Transit, by C. K. Hatcher and T. Schwarzkopf, attempts to provide the layman with an anecdotal and social account of the development of electrically-powered public transportation in Edmonton. The book is profusely illustrated and contains several maps. The work, unlike the works discussed previously, contains footnotes for much of the material. This book was designed primarily for the general public and was not intended to be a scholarly report.

While the book appears, initially, to be thoroughly researched and written, there are many instances where the authors have made unsupported statements, and where they have perpetuated errors found in previous works. One such example may be found on page 14 where Hatcher describes the external color scheme of the first streetcars. "The color scheme on these original cars when they were delivered is uncertain, but it is thought to have been two tones of brown". Hatcher does not cite any source for this information. It should be noted that the earliest reference to a two-tone brown paint scheme was the ETS pamphlet of 1966. Another example of an unsupported statement may be found on page 28 where it is stated, "About the same time, a spur was actually constructed in Edmonton from the ERR line on Jasper Avenue at Ninth (109) Street to the Hardisty Brothers Warehouse, so that freight could be delivered or picked up by the street railway". A press report

is cited. An analysis of that report shows that it made no reference to any spur in Edmonton. In addition, no record of the spur could be found in primary sources that were researched, including two ERR maps, one from 1908 and the other from 1911. These maps showed the extent of ERR trackage in those years.

Both authors mention and describe technical matters in a haphazard fashion. Hatcher, for instance, attempted to describe the methods and materials used in the permanent track construction of 1907 and 1908. His description, although extensive, failed to include the type, size and weight of the rails used. In addition, no mention was made of the type of special work installed nor the procedures required for proper installation. (see thesis Chapter III for further elaboration) The next type of construction that was described by Hatcher was the method that the ERR introduced in 1913 for the construction of permanent track. The methods and materials used between 1909 and 1912 were ignored, as well as most of the construction methods that were used after 1913.

In the sections that describe the trolley buses used in Edmonton, Schwarzkopf introduces several specialized terms such as "resistance heaters" and "Ohio Brass harps and shoes" (p. 149). He does not, however, explain what these items are or what the terms mean. It is left to the knowledge and the imagination of the reader to figure out what is meant by the terms. In addition, Schwarzkopf provides elaborate descriptions of the first 6 trolley buses purchased, including the names of the manufacturers of the traction motors and their horsepower (kW) rating. According to Schwarzkopf, the power of the traction motors was a significant factor in determining whether a particular type of trolley bus was suitable for use in Edmonton. (pp. 148-150 & p. 157) No further mention of trolley bus motors is made until Appendix III, where the reader

may discover that certain trolley buses built between 1947 and 1954 had motors that were rated at 140 H.P. (104.4 kW). (p. 195) The reader is not, however, informed of the name of the manufacturer nor the ratings or manufacturers of the motors installed on trolley buses built between 1942 and 1946. Although there are many more inaccuracies and unsupported statements in the book, it would be beyond the limits of this dissertation to cite further examples.

Edmonton's Electric Transit provides an extensive insight into the history of the streetcar and trolley bus in Edmonton. The numerous unsupported statements, as well as sketchy descriptions of technical terms and processes, tend to diminish the credibility of the book.

CHAPTER III

Track and Roadbed Construction

Initial Construction, 1907-1908

Well before the start of construction of the Edmonton Radial Railway (ERR), specific ideas and methods for track construction had been selected by City officials for possible use. The City Engineer's 1906 estimate for construction included a cross-sectional drawing of what the standard street railway roadbed would appear to be when completed, see Figure 1. A significant feature of that roadbed was the use of paving materials. At the time the estimate was made, no street in Edmonton was paved. Street paving began a year later, 1907, with the start of construction of Edmonton's street railway. (CEAR, 1908, p. 52) In order to accommodate large paving blocks, taller rails than normally used on conventional railroads were required.

In most instances, railroads that did not use paved roadbeds used T-type rails which conformed to the specifications of the American Society of Civil Engineers (ASCE). Rails which were designed specifically for street railways on paved streets were manufactured in two major types, high-T rail, sometimes referred to as Shanghai-T rail, and grooved girder rail. (Cyclopedia of Applied Electricity, Vol. III, pp. 84-85) Grooved girder rails will be discussed later in this chapter. High-T rail differs from the ASCE specifications in that the web of the high-T rail is taller and thinner. Figure 2 (after drawing of ERR Standard Rail Sections, December 1912) shows cross-sections of ASCE and high-T rail, both rails having a weight per yard of 80 pounds (33.2 kg/m).

The first rails ordered for the street railway, in early 1907, were

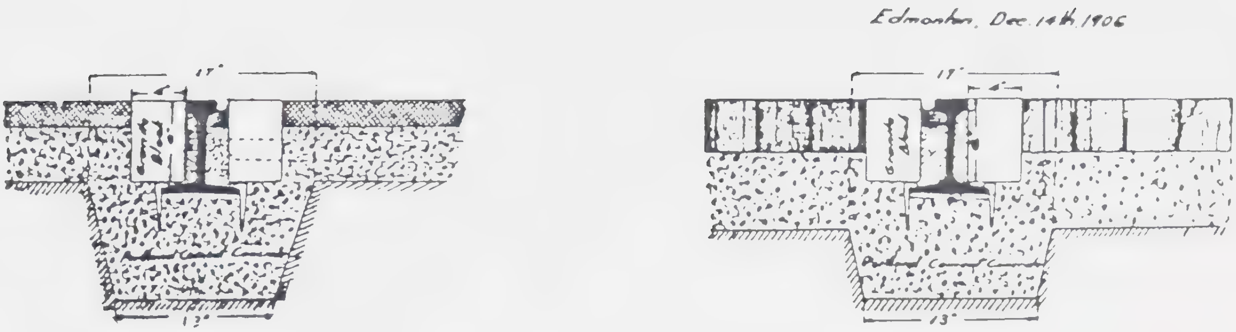


FIGURE 1. CROSS–SECTIONS OF PROPOSED TRACK CONSTRUCTION, 1906

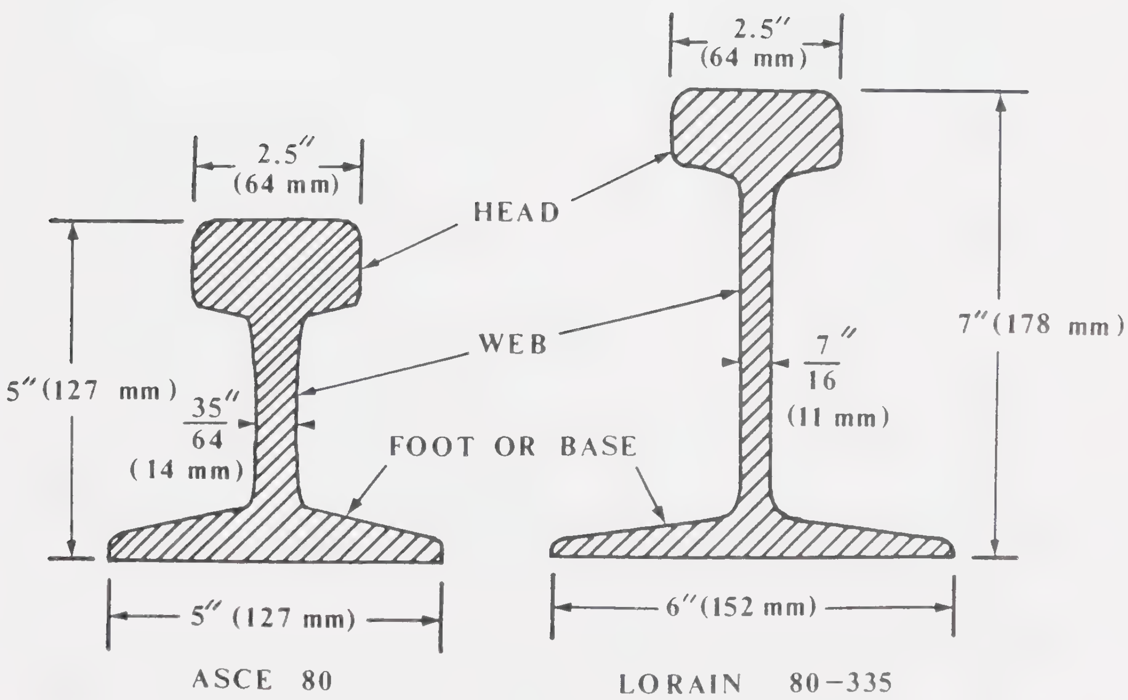


FIGURE 2. T–RAIL CROSS–SECTIONS

the high-T variety, manufactured by the Lorain Steel Company of Johnstown, Pennsylvania. This rail was classified as 80-335. (The Railway and Marine World, 1907, February, p. 111) The "80" referred to the weight, in pounds, of each yard of rail. The "335" referred to the style of rail section produced by the company. (Lorain catalogue 22, Tramway Rails, 1927) Before rails could be laid, a suitable sub-grade and grade had to be prepared.

It had ultimately been decided by Edmonton City Council that the main sections of the street railway would be of double-track construction. With double-track construction, two sets of tracks are laid in the street, each set of tracks equidistant from the centre of the street. One set of tracks would be used by streetcars travelling in one particular direction. The other set of tracks would be used by streetcars travelling in the opposite direction. In May 1907, construction crews began preparing the roadbed by ploughing the centre portion of Jasper Avenue between First and Ninth Streets (101st and 109th Streets). This work was carried out by private contractors under the supervision of the City. (CEAR, 1908, pp. 50-51) It is a common belief that horses were the only means by which ploughing, grading or other construction equipment could be hauled. Photographs from that era show that horses were not used exclusively during the ploughing of Jasper Avenue. Plate 1 (City of Edmonton Archives) shows a crew ploughing Jasper Avenue at First Street (101st Street). To perform this operation, a steam roller is being used to pull the plough. As will be discussed in a subsequent section, steam powered devices were used in other aspects of street railway construction in Edmonton.

The sub-grade for double-track consisted of a trench approximately 22 feet 2 inches (6 756 mm) wide, excavated to a depth of approximately

Plate 1. (City of Edmonton Archives) Ploughing Jasper Avenue in 1907

8 inches (203mm) below the existing surface of Jasper Avenue. This sub-grade was not intended to bear the total weight of the rails. In order to support the rails further and in order to keep them at a pre-determined height, four rows of wooden spike blocks were set into the sub-base parallel to the sides of the trench. The rows of spike blocks were so placed that when the running rails were laid, the distance between the track centres would be 12 feet (3 658 mm). In each row of blocks, each block was placed so that it would lie directly beneath a running rail. Along each row, the individual spike blocks were spaced approximately 15 feet (4 572 mm) apart, and were held in place with concrete. (CEAR, pp. 51-52) The gauge, the distance measured between the facing sides of the rail heads, used for track laid on Edmonton's street railway was the standard 4 feet 8 1/2 inches (1 435 mm). To hold the running rails to this gauge, some sort of cross-tie had to be used. In the initial construction, steel ties were used. They were made from old 56 pound per yard (23.2 kg/m) T-rail that was cut into 6 foot (1 829 mm) lengths. (CEAR, p. 51) These "ties" were installed in an inverted position, perpendicular to the sides of the trench at intervals of 15 feet (4 572 mm). The ties were also placed so that they were midway between the spike blocks. Sections of running rails (Lorain 80-335), which were usually shipped in lengths between 30 and 33 feet (9 144-10 584 mm), were bolted together at the ends and were attached to the steel ties by clamps which were bolted in place. The running rails rested on the spike blocks previously set down in the sub-base. At this juncture, crews aligned the rails vertically using shims that were placed under the ties, and aligned the rails laterally by shifting the rails with pinch bars. After the rails were aligned, the crews attached the running rails to the spike blocks with ordinary railroad spikes. (CEAR, pp. 51-52) Plate 2 (City

Plate 2. (City of Edmonton Archives) First Stages of Permanent Construction on Jasper Avenue, 1908


Rail
Tie
Spike Block

Plate 2. (City of Edmonton Archives) First Stages of Permanent Construction on Jasper Avenue, 1908

of Edmonton Archives) shows what the track construction looked like at this point. The spike blocks, steel ties and running rails are clearly visible in this plate and are labelled on the overlay.

In the next stage of the construction, concrete was poured into the trench and was tamped in and around the rails and ties and levelled so that approximately the upper half of the running rails remained exposed. (CEAR, 1908, p. 52) Plate 3 (Provincial Archives of Alberta) photographed in the fall of 1907 on Jasper Avenue just west of present-day 103rd Street, presents a clear view of track construction after the concrete had been poured. One should note the inverted rails used as steel ties. The large wire attached to the base of both running rails and labelled "cross-bond" on the overlay, was installed to enable the electricity used by the streetcars to return to the generating station evenly and with as little resistance as possible through both running rails. A more detailed discussion of cross-bonds may be found in a subsequent chapter.

The final step of the initial construction was to pave the street in order to provide an even, generally smooth surface for pedestrians and vehicles. The paving material selected for streets that had tracks was specially treated wood blocks. The blocks, referred to as "Carbolineum wood block", were treated with a carbolic acid compound which was supposed to retard their decay. (CEAR, 1908, p. 52) A major disadvantage of using these blocks was that it was necessary to lay them by hand. In consequence, large numbers of men were required to lay the paving blocks in order to make substantial progress. Plate 4 (City of Edmonton Archives) shows paving in progress in an easterly direction along Jasper Avenue between present-day 101st and 100th streets in mid 1908. In addition to the large crews required, special care was necessary when fitting the blocks near street railway tracks. The blocks were

Plate 3. (Provincial Archives of Alberta) Detail of 1907 Permanent Construction

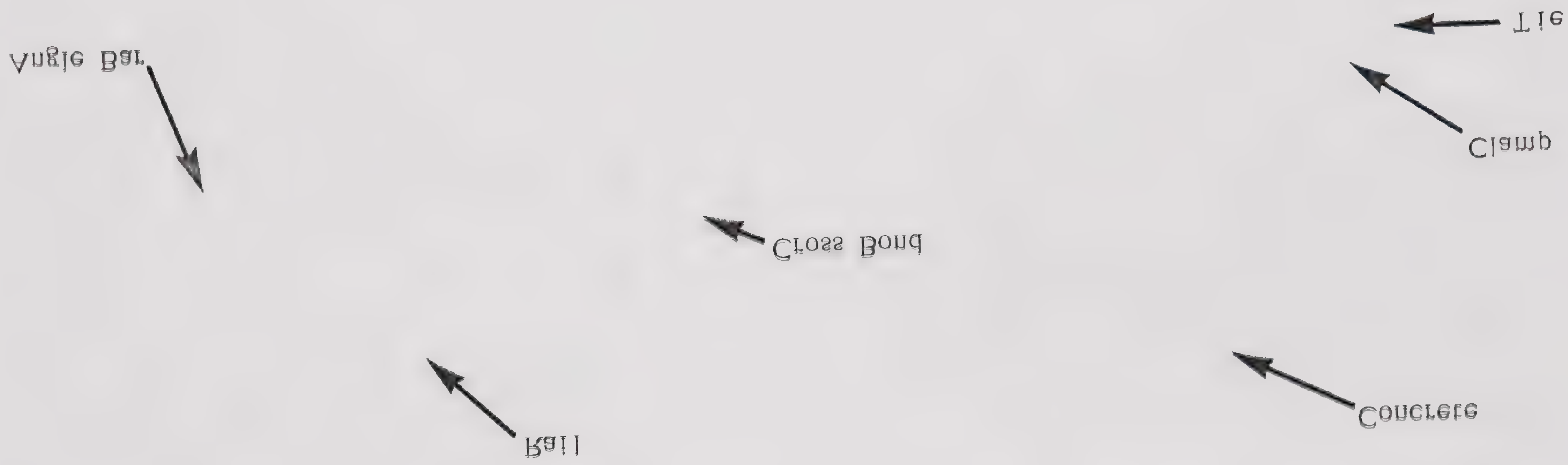

Tie
Angle Bar
Clamp
Cross Bond
Concrete
Rail

Plate 3. (Provincial Archives of Alberta) Detail of 1907 Permanent Construction

Plate 4. (City of Edmonton Archives) Crews Installing Wood Block Paving, 1908

designed to lie level with the tops of the running rails. Since most streetcars had flanged wheels, the edges of the blocks that were placed against sides of the rails where the flanges would pass had to be chamfered. If this was not done, the streetcar wheel would not remain on the head of the rail and the streetcar would probably leave the track. Once the paving was complete, the construction of the street railway track was considered finished. Figure 3 (based on descriptions in (CEAR, 1908, pp. 51-52, and Harding & Ewing, 1926, p. 285) shows a cross-section

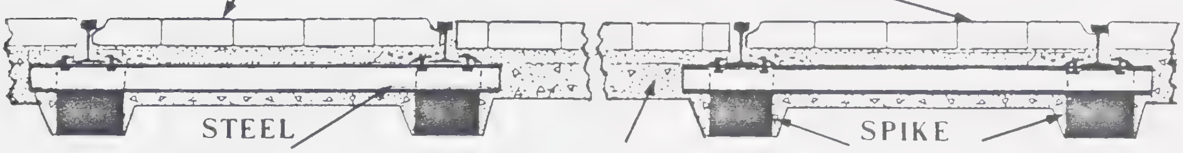


FIGURE 3. CROSS-SECTION OF DOUBLE-TRACK, 1907 STANDARD

through completed double-track built to the 1907 standard. This type of track construction was referred to, by city officials, as "permanent track". (CEAR, 1908, p. 51) A total of .58 miles (0.93 km) of permanent double-track was laid in 1907. An additional 1.303 miles (2.1 km) were laid in 1908.

To this point, the description and discussion of track and track laying has been limited to tangent (straight) track. Where tracks curved, branched off, crossed or intersected, special trackwork was required. Such trackwork was usually referred to as "special work". (Doane & Parkham, 1926, § 19 p. 32) Curved sections could normally be constructed locally, but switches and complex intersections were usually beyond the capabilities of most city shops. In addition, special hard-wearing steel

alloys, usually manganese steel, were required for various pieces of the special work if it was to last more than a few years in service. (Doane & Parkham, § 19 pp. 35-36) In most instances, therefore, special work was constructed by various steel companies and by contractors. Prepared special work was usually shipped to its destination unassembled. It was eventually assembled by crews on its permanent site. By early 1907 it had been decided, by Edmonton City Council, that the double-track line to be constructed along Jasper Avenue would have a double-track branch-off to the north at First Street (101st Street). Map 1 shows the location of Jasper Avenue and First Street. The design of special work required for this type of intersection is known as a "three-part Y". (Doane & Parkham, § 19 p. 32) It consisted of six switches and eighteen frogs connected by sections of straight and curved track. A description of switches and frogs will be found in a subsequent section. When completed, the three-part Y, when looked at in plan view, resembled a capital letter "Y". The Falk Company, a contracting firm in Milwaukee, Wisconsin, fabricated the first three-part Y for the street railway. The special work arrived in 1907 and was installed during that year. (Correspondence between City Engineer, City Commissioners and the Falk Company, October 1907) A blueprint which showed the general appearance of the special work, in plan view, and which also included assembly instructions was sent as well. Figure 4 (after Falk Company blueprint showing construction layout of three-part Y at First and Jasper, May 1907) shows the general plan view of the three-part Y installed at Jasper Avenue and First Street. The arrows indicate the usual operations through a three-part Y.

The shape of the rail used in the construction of special work differed significantly from T-rail. Since most of the special work

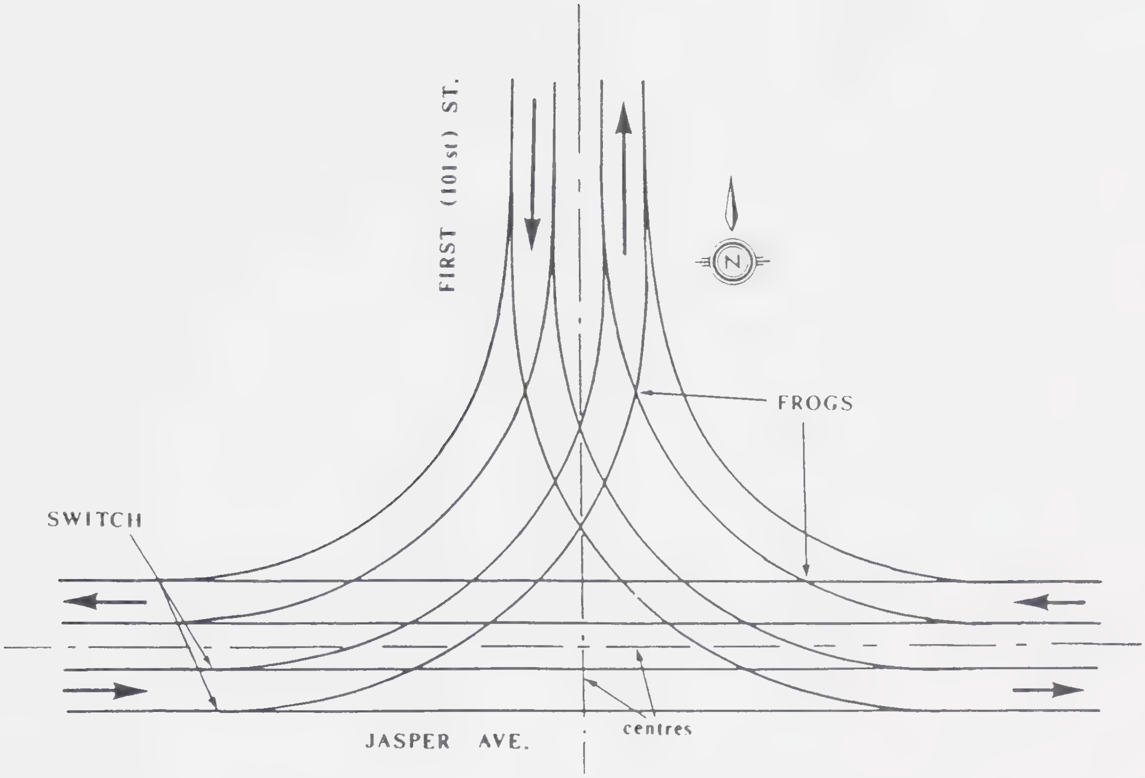


FIGURE 4. THREE-PART Y

consisted of curved sections of rail, it was necessary to use special rails which were designed to prevent the streetcar wheels from climbing the rails. Doane and Parkham (1926) wrote:

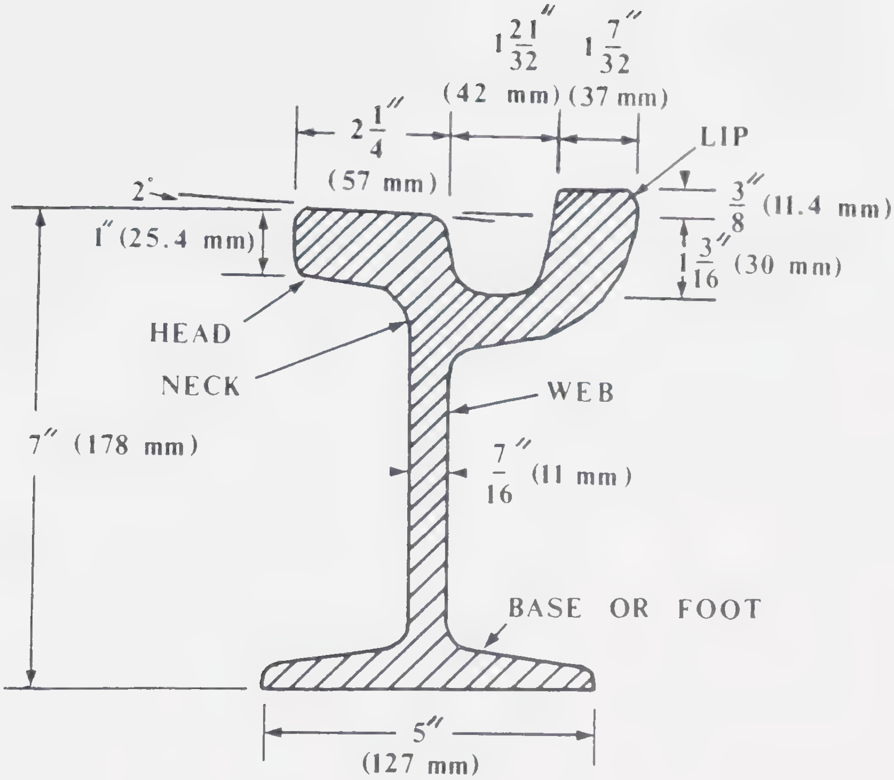
> When a car rounds a curve, the flange of the forward outer wheel presses against the gauge line [side of the head] of the outer rail. The contact of these two surfaces guides the car around the curve and causes a tendency for the wheel to climb the rail. . . . To prevent climbing, curves are laid with a guard feature which may be either part of the running rail itself or a separate rail laid alongside the running rail. (§ 19, p. 17)

In most special work used in Edmonton, the "guard feature" referred to was a type of grooved girder rail which had, as part of the side of the rail head, a high "lip" which was supposed to prevent the streetcar wheel flanges from climbing off the rail. This guard rail, which was usually the same height as the rails joining it, was heavier due to the weight of the lip. Two brands of grooved girder guard rail were used

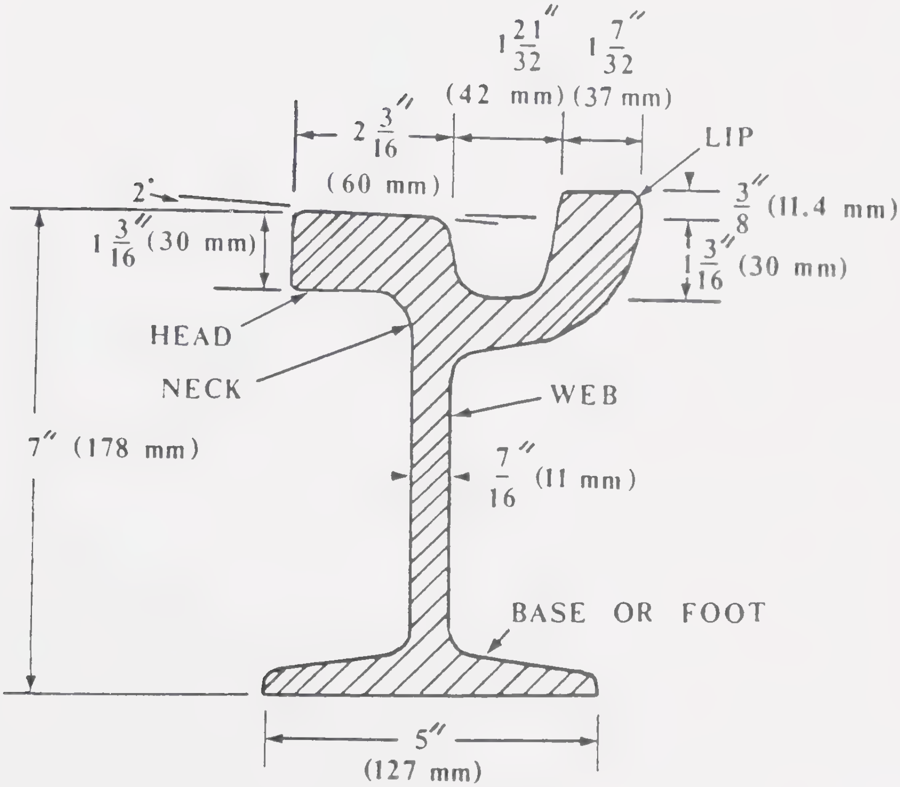
in special work constructed for Edmonton in 1907 and 1908. They were Lorain 108-398 and Hadfields D.K. 96c. It is important to note that the classification given for the Hadfields rail makes no reference to the weight of the rail, while the first three digits of the classification given for the Lorain rail signify the weight, in pounds, of 1 yard (0.91 m) of rail. The Lorain rail, manufactured in the United States had a weight per yard of 108 pounds (44.8 kg/m). The Hadfields rail, manufactured in Sheffield, England, had a weight per yard of 110 pounds (45.6 kg/m). (Hadfields Steel Foundry cross-sectional drawing of D.K. 96c guard rail, 1911) The heavier weight of the Hadfields rail was due to it having a slightly wider and thicker head than the Lorain rail. Figure 5 (after drawing of ERR Standard Rail Sections, December 1912) shows cross-sections of Lorain 108-398 and Hadfields D.K. 96c grooved girder guard rails with the major parts identified.

The method used to install special work was somewhat different than the method described for installing tangent track. Once the trench had been excavated and the spike blocks set, large, widely-spaced wooden ties were placed in the trench. The pieces of the special work were then placed in the trench on top of the ties. To facilitate assembly, each piece of the special work was numbered by the manufacturer. Assembly began with the crews matching the numbers on the ends of the various pieces. If this was done correctly it was unlikely that the special work would be incorrectly assembled. Once all the parts were accounted for and matched, the pieces were bolted together at the ends. Plate 5 (City of Edmonton Archives) shows crews assembling the three-part Y at Jasper Avenue and First Street in 1907. The photograph was taken on Jasper Avenue looking north on First Street. The numbers on the sides of the special work pieces as well as the wooden ties should

Plate 5. (City of Edmonton Archives) Three-Part Y on Jasper Avenue and First Street, 1907



LORAIN 108−398



HADFIELDS D.K.96c

FIGURE 5. GUARD RAIL CROSS−SECTIONS

be noted. When all sections were bolted together, the ends of the special work assembly were aligned with the ends of the tangent track leading to the special work. The assembled special work was then bolted to the ends of the tangent tracks and spiked to the spike blocks and to the wooden ties. Concrete was poured in and around the special work and was levelled so that approximately the upper half of the rails remained exposed. When the concrete had set sufficiently, wood block paving was installed in the same manner as that previously described for tangent track. Special work constructed in this manner was considered to be "permanent work". (CEAR, 1908, pp. 51-52) Only one other piece of permanent special work was installed during the initial construction of 1907 and 1908. It was a three-part Y located at the intersection of Jasper and Namayo Avenues (97th Street).

It was mentioned earlier in this section that guard rails were required on curves in order to prevent the streetcars' wheels from climbing off the rail. It was also stated that the curved sections of grooved girder guard rail for special work arrived already bent to the proper radius. The construction of permanent track curves, other than those in special work, presented some problems. Most street railways had the tools necessary to bend properly ASCE and high-T rail into curved sections, but very few properties had the facilities and equipment to bend grooved girder guard rail properly. It was possible to order custom fabricated curved guard rail sections from the manufacturers, but this was costly. A cheaper alternative was to bend the ASCE or the high-T rail to the proper radius and then to affix a pre-fabricated rolled-steel guard to the web of the rail using bolts. The pre-fabricated guard was known variously as "T-guard rail" (Doane and Parkham, 1926, § 19 p. 18), and as "'D' guard". (Drawing of ERR Standard Rail Sections, December 1912)

The "D" guard, as it was known in Edmonton, consisted of two parts. The lip, which provided the flangeway and guard and a support bar which, when bolted to the web of the rail, held the lip tightly against the underside of the head and to the web of the rail. Figure 6 (after drawing of ERR Standard Rail Sections, December 1912) shows a cross-section

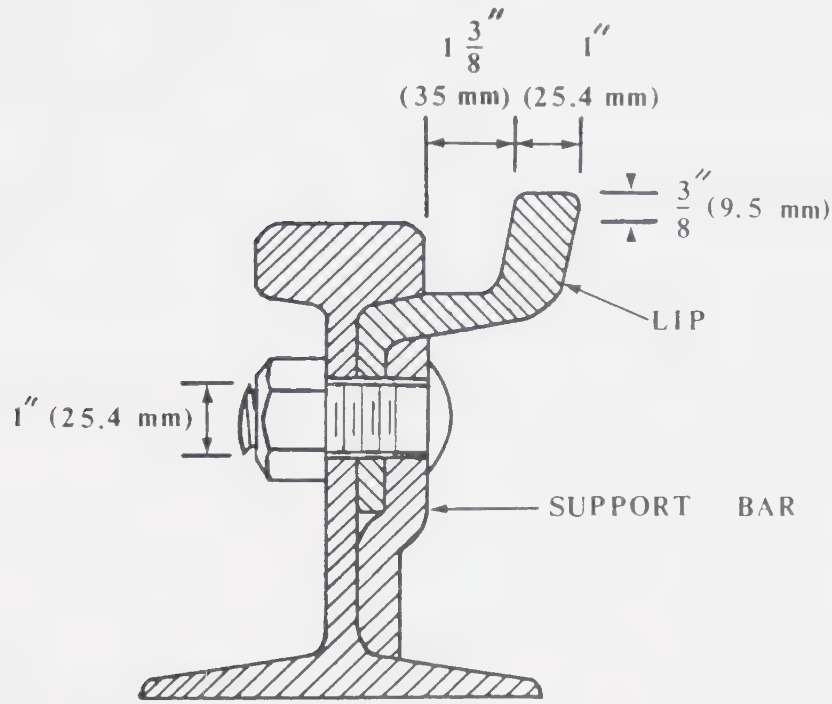
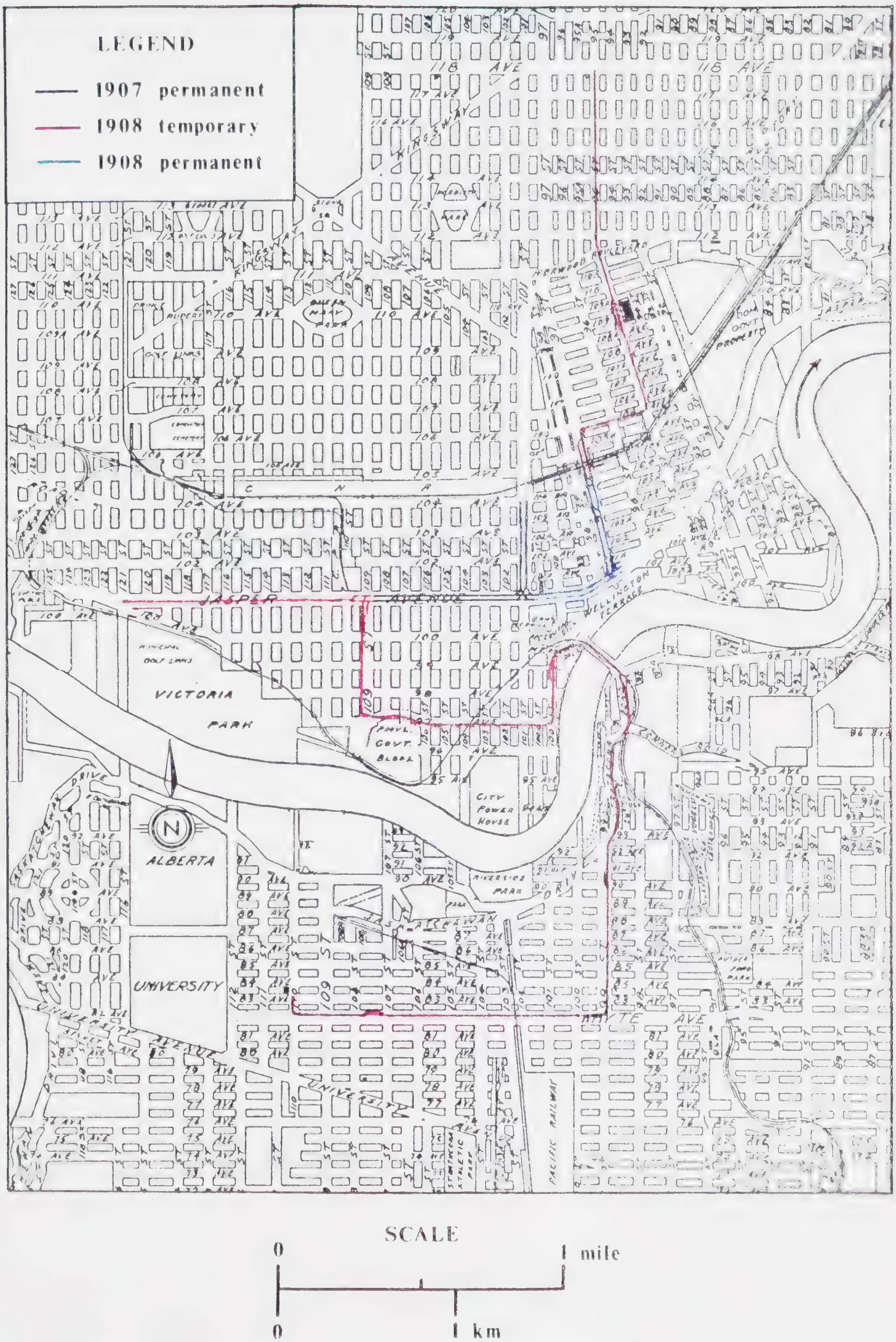


FIGURE 6. CROSS-SECTION OF LORAIN 80-335 WITH "D" GUARD

of Lorain 80-335 high-T rail with "D" guard attached. The dimensions and names of the guard pieces are indicated. (See figure 2 for dimensions and names of parts for Lorain 80-335 rail) The first use of "D" guard was on the double-track curves on Jasper Avenue at Queens Avenue (99th Street). Map 3 (after: Mundy's Street Index Map of Edmonton, 1915; Official Map of the City of Edmonton, 1938; CEAR, 1908, pp. 51-52, 81; CEAR, 1909, pp. 100-102) shows the extent and location



MAP 3. EXTENT & TYPE OF CONSTRUCTION 1907–1908

of permanent track constructed in 1907 and 1908.

Temporary Construction, 1908

Permanent double-track was not the only type of track constructed before the start of streetcar operation in November 1908. Although only permanent double-track was constructed in 1907 and in the first seven months of 1908, a substantial distance of single and double "temporary track" was constructed between August and November 1908. (CEAR, 1908, p. 81) The term "temporary track" referred to either single- or double-track laid with ASCE section rails, usually 60 pounds per yard (24.9 kg/m), spiked to wooden ties. The roadbed consisted of graded, unpaved streets. The track was held in place with a mixture of earth and gravel ballast. (CEAR, 1909, p. 97) The ties that were used for this construction differed in size and shape from the standard street railway wooden tie. Doane and Parkham (1926, § 19 p.6) as well as several Edmonton Radial Railway track cross-sections dating from 1910, describe the standard street railway tie as having a length of 8 feet (2.44 m), a width of 8 inches (203 mm) and a height of 6 inches (152 mm). Most wooden ties used in Edmonton were sawn from fir, tamarack (larch) or spruce logs. In the 1908 temporary track construction, however, only two parallel faces were sawn on logs destined to be ties. No creosote or other preservative was used. The half-sawn ties were then placed on the graded road at intervals of about 2 feet (610 mm). The rail was then placed directly onto the ties, no tie plates were used. The rail sections were bolted together at the ends using standard angle bars and bolts. This method was similar to that used to connect sections of high-T rail in permanent work. A notable difference in temporary track, however, was that the joints in each rail were so placed that

they were not opposite joints in the other rail. It was intended that each joint would be across from the centre of the rail-section of the opposite rail. Track that employed this type of rail joint location was commonly referred to as being "broken jointed". (Doane & Parkham, § 19 p. 26) Once the rail sections were properly bolted together, the ties were re-spaced so that there was a tie on either side of a joint, each tie being placed as close as possible to the centre of the joint. No tie, however, was placed directly beneath the centre of the joint. The joints were, therefore, commonly referred to as "suspended joints" because the rail sections met between ties. (Doane & Parkham, § 19 p. 26) With the aid of a track gauge and spike mauls, crews were able to spike the rails to the ties by hand. The use of a track gauge ensured that the rails were kept to the proper gauge. Ballast was then deposited on the track by horse-drawn wagons, and crews tamped it in place between and under the ties. The ballast was also distributed so that it sloped down from the centre of the track towards the ends of the ties. When ballasting was finished, the construction was considered to be complete. Plate 6 (Provincial Archives of Alberta) shows some temporary track that was laid using the aforementioned methods. The photograph was taken in the fall of 1908 in the City of Strathcona. The photographer was facing north on 5th Street North-East between 9th and 10th Avenues North-East (now known as 99th Street between 91st and 92nd Avenues, see map 1 for locations). The location of the rail joints, the spacing of the ties and the ballast should all be noted.

There appears to have been two major factors in the decision to switch from permanent to temporary construction. One factor was financial considerations. As early as October 1907, it was known that the City of Edmonton was running short of money. (Letter from Mayor

Plate 6. (Provincial Archives of Alberta) Temporary Track in Strathcona, 1908

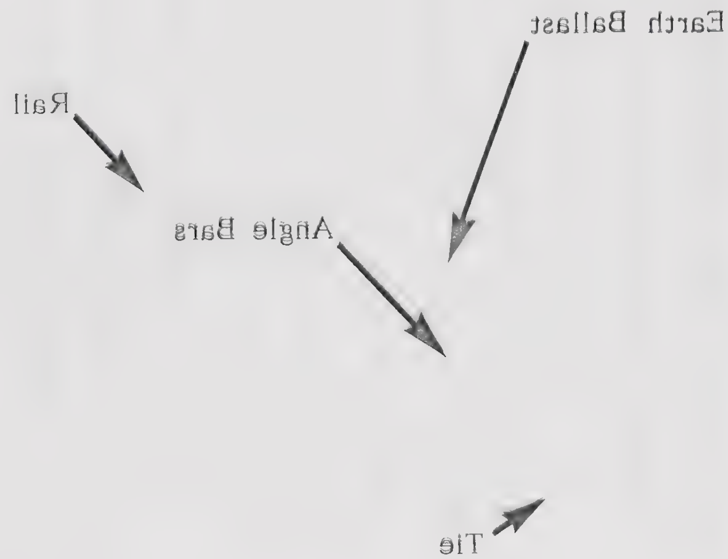

Earth Ballast
Rail
Angle Bars
Tie

Plate 6. (Provincial Archives of Alberta) Temporary Track in Strathcona, 1908

W. A. Griesbach to "Public Service", October 16, 1907) While permanent track provided an ideal track, it was expensive and slow to construct. Temporary track, while not as substantial and esthetically pleasing as permanent track, was cheaper to construct and could be built faster. In addition, the City of Edmonton purchased the Strathcona Radial Tramway Company in August 1908 and agreed to construct an interurban line from Edmonton to various points in the City of Strathcona (see Chapter II for background of the Strathcona Radial Tramway Company). At this juncture, the street railway under construction in Edmonton and soon to be extended to Strathcona, became known variously as the Edmonton Radial Railway (ERR), or the City of Edmonton Street Railway Department. (City of Edmonton Bylaw 184, August 1908) A superintendent, Charles E. Taylor, was appointed at this time as well. Taylor had the authority to order equipment and supplies and to decide on what construction methods to be used, subject to the approval of the City Commissioners. (City of Edmonton Minutes of Council, Meeting 42, August 4, 1908)

A grand total of 6.71 miles (10.8 km) of temporary track was constructed in 1908. The figure is based on the total length of all temporary track laid, calculated as single-track. Lengths of double-track would, therefore, be added twice. Only 600 feet (183 m) of double-track, 1,200 feet (366 m) if counted as single-track, was constructed in that year. It was laid on Namayo Avenue (97th Street) from Isabella Street (104th Avenue) to Griesbach Street (105A Avenue). (CEAR, 1909, p. 100) Since the interurban line was all single-track construction, passing tracks (turnouts) were installed at several locations to enable streetcars travelling in opposite directions to pass each other. Map 3 (after Official Map of the City of Edmonton, 1938, and drawing Showing Position of Poles

and Track, 1908) shows the location and extent of temporary track constructed in 1908. The passing tracks on Syndicate Avenue (95th Street) and on Curry (100th) Street in Edmonton, as well as those on Fifth (99th) Street and on Whyte (82nd) Avenue in Strathcona should be noted. As well, the frequent location of the track near the side of the road should be noted. There appears to be two possible explanations as to why this was done. By placing the temporary track at the side of the road, there would be minimal interference with vehicular traffic since the tracks were not paved. The other explanation is that the ERR anticipated replacing the temporary track with permanent double-track at an early point in the future. By having the temporary track at the side of the road, construction of the permanent track in the centre of the road could take place without disrupting streetcar service. Support for both explanations will be found in subsequent sections of this chapter.

Special work in temporary construction included crossings, branch-offs (switches) and frogs. In addtion, a left hand crossover was installed on Jasper Avenue immediately west of Ninth (109th) Street. A crossover was a unit of special work which enabled a streetcar, travelling in a certain direction on a double-track line, to cross from the track it was on, over to the other track. Crossovers were used mainly to enable double-end streetcars (streetcars that could be operated from either end) to keep on the proper side of the road when they reversed their direction of travel. In addition, crossovers were also used to divert streetcars from one track to the other in emergencies or when one track was blocked. (Doane & Parkham, 1926, § 19 p. 32) There were two major types of crossovers used on Edmonton's street railway. Left hand, which enabled streetcars to change tracks while travelling forward, and right hand, where streetcars had to reverse direction in order to change tracks.

Figure 7 (after plan of ERR Standard 10 ft. crossover, June 1913) shows the general appearance, in plan view, of a standard right hand crossover.

FIGURE 7. PLAN OF RIGHT HAND CROSSOVER

An unusual feature was the special track laid across the Saskatchewan Bridge (now the east half of the Low Level Bridge). The bridge was originally built to carry the Edmonton, Yukon and Pacific Railway (EY&PR) (now part of Canadian National Railways; bridge portion abandoned) vehicles and pedestrians across the North Saskatchewan River. The railroad track was placed in the centre of the bridge. Any alteration or expansion by a chartered railroad was subject to the approval of a Federal regulatory agency known as the Board of Railway Commissioners

(BRC), now the Canadian Transport Commission. The BRC also had some jurisdiction over most Canadian street railways. Whenever a street railway wished to cross a railway chartered by the Federal Government, the street railway had to submit plans of the proposed crossing to the BRC for approval. The street railway, furthermore, could not legally use the crossing until approval was granted. It should be noted that the BRC could refuse approval, or could order changes to be made. (Letter to C. E. Taylor from J. Bown, City of Edmonton Solicitor, November 25, 1909) On November 24, 1908, the BRC gave its approval to the ERR's proposal to cross the EY&PR and to use the west side of the Saskatchewan Bridge. (Board of Railway Commissioners' Order No. 5691, November 24, 1908)

The bridge deck was 18 feet (5.49 m) wide. It was felt by the City Engineers and by the Superintendent of the ERR that if the street railway track was laid near one side of the bridge, there would be enough space for a wagon to be on the bridge while a streetcar was crossing. (Drawing of Vertical Sections Through Bridge Showing Position of Cars, August 1908) Since there was not enough space on the deck of the bridge to place another set of tracks next to the railroad track, the ERR track was so placed that, at either end of the bridge, one rail crossed the western rail of the EY&PR and travelled between the rails of that railroad. This arrangement was known as "gauntlet track". (Doane & Parkham, 1926, § 19 pp. 36-37) It should be noted that wooden planks were placed around and between the rails on the bridge in order to provide a smooth surface for road vehicles. Figure 8 (after drawings Showing Position of Poles and Track in Edmonton and Strathcona, 1908, and Provincial Archives of Alberta photograph A.1387) shows the plan view of the gauntlet track constructed across the Saskatchewan Bridge.

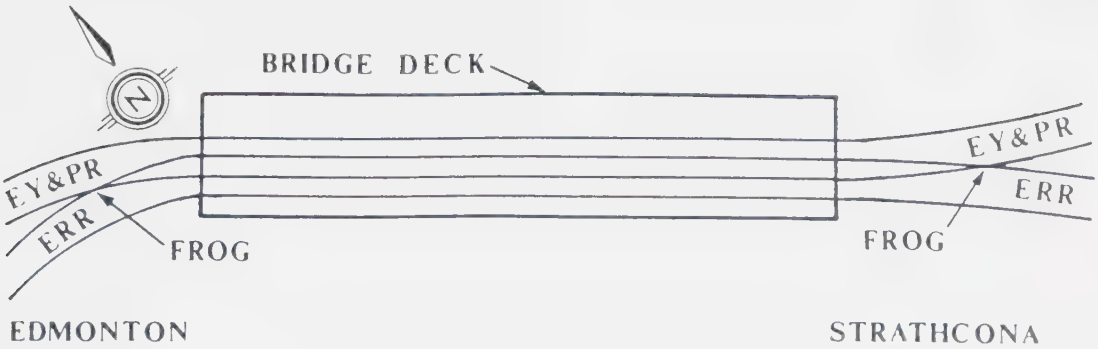


FIGURE 8. PLAN OF GAUNTLET TRACK ON SASKATCHEWAN BRIDGE

It can be seen in Figure 8 that the ERR rail crossed the EY&PR rail by means of frogs. These frogs, and those mentioned earlier in this chapter, were pieces of fixed special work which enabled two rails to cross at angles less than 90°. The frogs consisted of four pieces of T-rail bolted or riveted to a supporting plate which held the rails to the correct angle and which provided a flangeway for the wheels. The rails were also formed so that they provided a smooth and even crossing for the wheels. Figure 9 (after drawing of Standard Riveted Plate Frog, August 1908) illustrates the general appearance of the type of frogs used on the ERR in 1908.

Permanent Construction, 1909

The method and the materials of construction that were used in 1909 differed from those used previously. The first step in the new construction of permanent track began with contracting crews excavating a flat-bottomed trench in the centre of the road to a depth of approximately 22 feet 2 inches (6 756 mm). A 4 inch (102 mm) layer of concrete was then deposited and smoothed along the bottom of the trench.

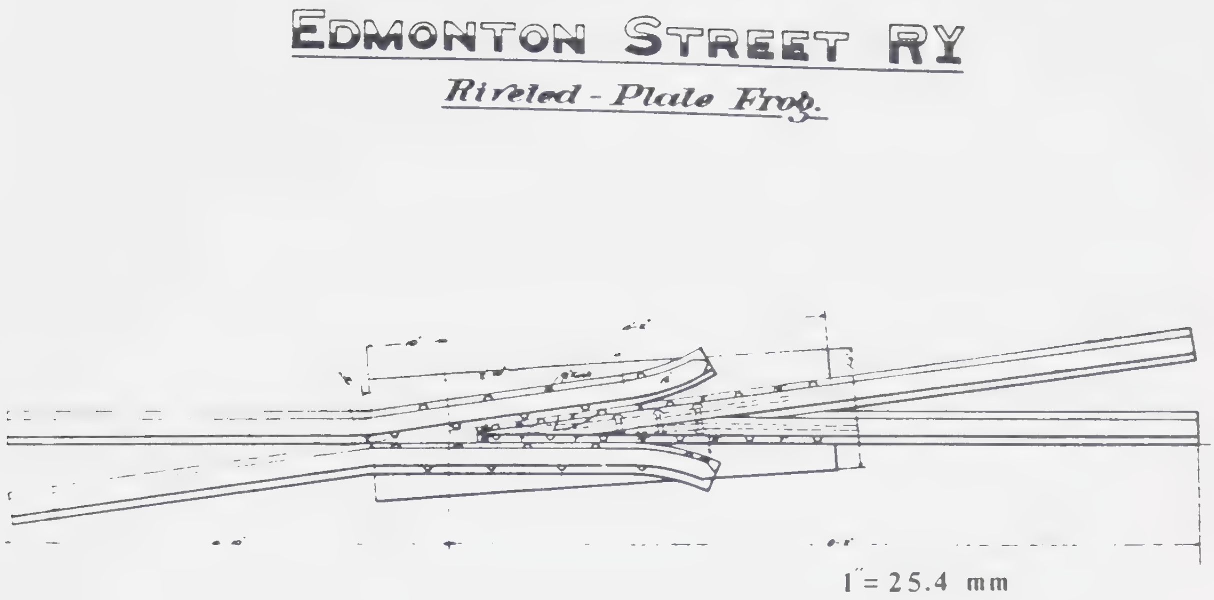


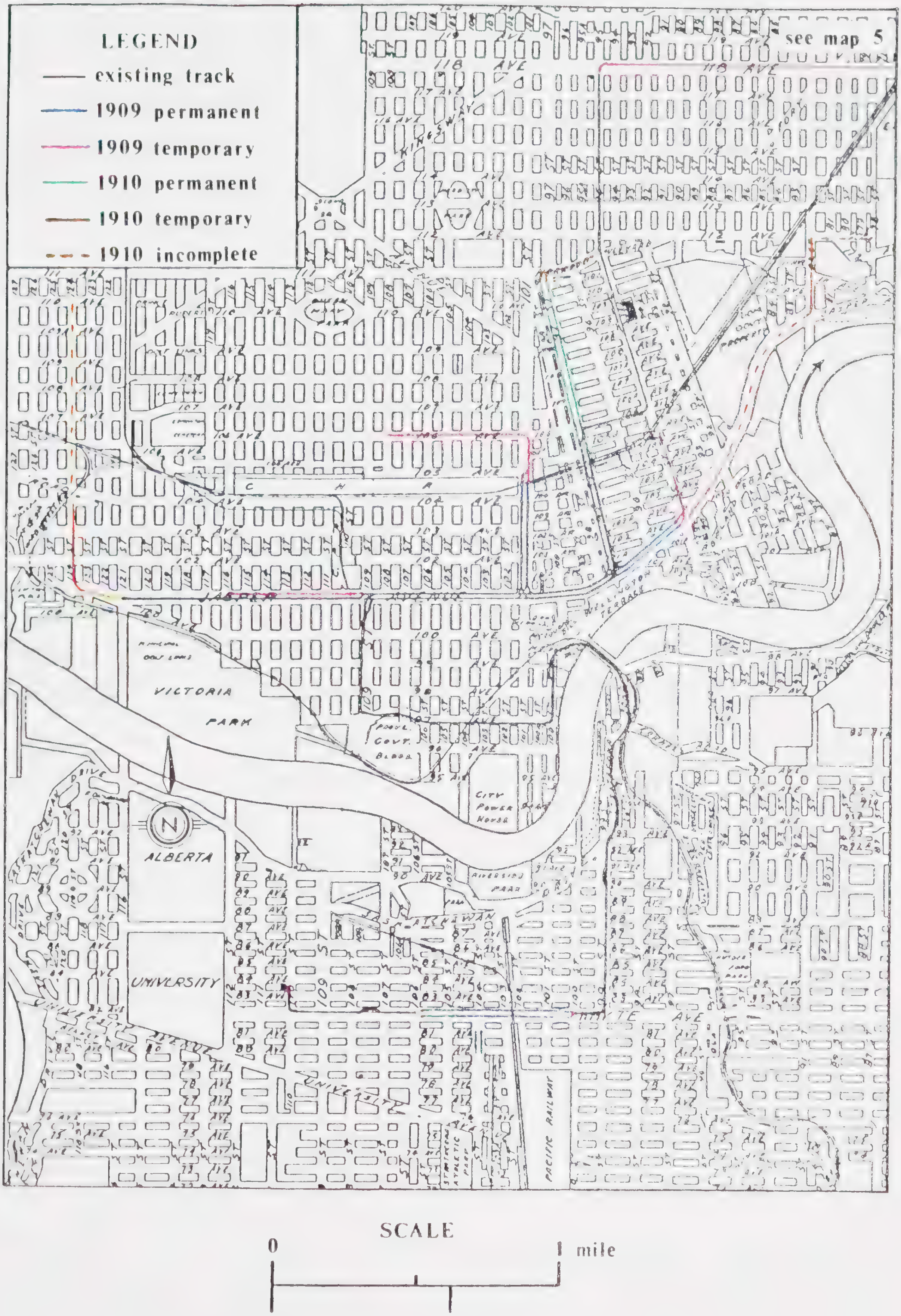
FIGURE 9.

When the concrete had hardened sufficiently, wooden ties were placed on the concrete perpendicularly to the edges of the trench at intervals of approximately 2 feet (610 mm). The ties, made from fir, spruce or tamarack, were cut to a length of 8 feet (2.44 m), a width of 8 inches (203 mm) and a height of 6 inches (152 mm). Lengths of 80 pounds per yard (33.2 kg/m) ASCE T-rail were then placed directly on the ties. The rail lengths were bolted together at the ends and the rails were then gauged and spiked to the ties. The track centres were 12 feet (3 658 mm) apart. Concrete was then deposited in the trench and was levelled with the tops of the rail heads. In addition, flangeways were formed in the concrete before it hardened. (CEAR, 1909, p. 97, and drawings of Sections of Track Construction, 1909-1913) Although this method of construction was less expensive than that used in 1907 and 1908 because of the use of wooden ties and ASCE-section rail, there was another reason why the 1907-1908 method was not continued. The

carbolineum wood-block paving used in the initial construction had swelled when exposed to moisture and, in some instances, had risen from the concrete bed and interfered with the operation of the streetcars. The condition became so severe that the blocks were removed from between the rails and tracks on Jasper and Namayo Avenues (97th Street). (CEAR, 1909, p. 97) The use of concrete as a paving material in the 1909 construction eliminated this problem. It was not feasible, however, to pave the entire street with concrete, because the extreme temperature fluctuations in the City coupled with heavy traffic on paved streets would cause the concrete next to the rails to crack. The road surface would, therefore, become rough and uneven. It should be noted that the concrete used in the 1909 construction did not have any internal reinforcing and expansion joints were not used. In the 1909 Annual Report, Superintendent Taylor wrote,

> This form of construction has been used in many parts of America with good satisfaction but for heavy City traffic the Department [Street Railway Department or ERR] will for future track laying have to secure either granite sets or paving brick for use between the road paving and the rail. (p. 97)

A total of 0.71 miles (1.14 km) of permanent double-track was constructed in 1909. The distance is equivalent to 1.41 miles (2.27 km) if the construction is reckoned as single-track. (CEAR, p. 101) The distance of permanent double-track constructed in 1909 was less than the distance constructed in 1908. In addition, most of the 1909 permanent track was constructed on Whyte (82nd) Avenue in Strathcona, replacing the temporary track laid in 1908. The remainder of the 1909 permanent construction extended double-track lines constructed previously. Map 4 (after Official Map of the City of Edmonton, 1938, and (CEAR, 1909, p. 101) shows the location of permanent double-track constructed in 1909.



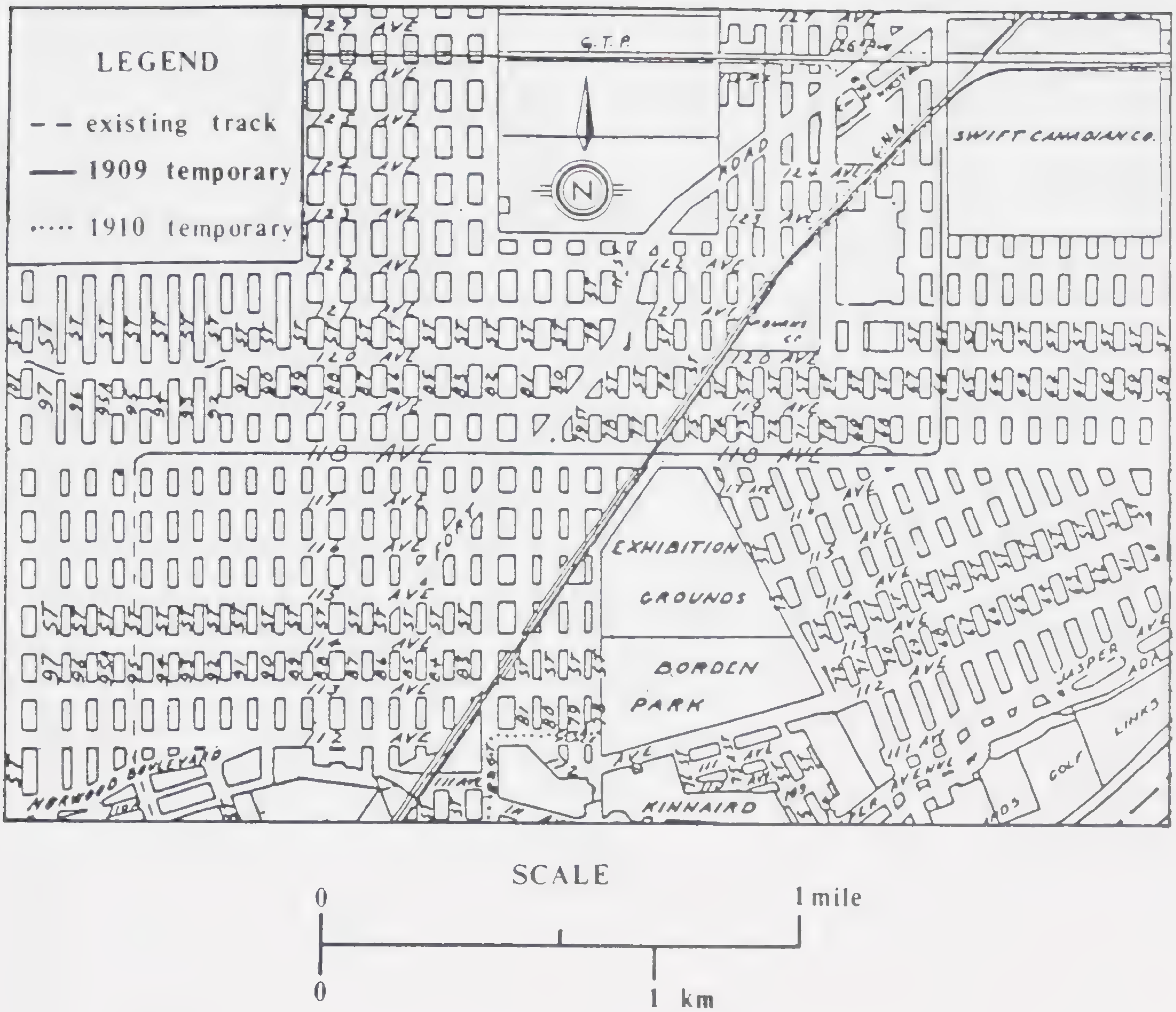
MAP 4. EXTENT & TYPE OF CONSTRUCTION 1909–1910

Temporary Construction, 1909

The methods used for the construction of temporary track in 1909 were quite similar to those described for 1908. It appears, however, that the ballast used in 1909 consisted solely of gravel. (CEAR, p. 97) Calculated as single-track, the total distance of temporary track constructed in 1909 was 4.27 miles (6.87 km). (CEAR, p. 102) Of that distance, 250 feet (76.2 m) of double-track (not counted as single-track) and 730 feet (222.5 m) of single-track was constructed by ERR crews with assistance and guidance from the City Engineers. This construction was located on First (101st) Street between the railroad crossing and Vermilion (106th) Avenue. This was the first occasion when City crews undertook construction of track, including the roadbed. (CEAR, p. 102) Maps 4 and 5 (both after Official Map of the City of Edmonton, 1938, and CEAR, 1909, p. 102) show the location of temporary track constructed in 1909.

Freight Track, 1909

The ERR could carry freight as well as passengers. Although freight could be transported along the same tracks as passengers, the origins and destinations of freight usually differed from those of passengers. Where volume, frequency or weight warranted, a special track could be constructed from a passenger track to an appropriate location for the sole purposes of collecting or delivering freight. These freight only tracks were constructed in a manner similar to the method used in the construction of temporary passenger track. It has been mentioned, in previous sections, that much of the material for track construction was not manufactured locally. These materials were usually brought and



MAP 5. NORTHEAST CONSTRUCTION, 1909–1910

delivered by rail to the City at their yard, which was located north of Clark Street (105th Avenue) between Kinistino and Syndicate Avenues (96th and 95th Streets). To assist with the movement of construction materials to the ERR, a single freight track was constructed from the single-track line on Syndicate Avenue (95th Street) at Clark Street (105th Avenue) into the City yard. (Edmonton Evening Journal, 1909, April 15, p. 8) Access to the freight track was provided by a left hand branch-off (switch) located on Syndicate Avenue (95th Street) at Clark Street (105th Avenue). Map 4 (after Official Map of the City of Edmonton, 1938, and Driscoll's and Knight's Map of Edmonton, 1909) shows the location of the freight track into the City yard.

Reconstruction, 1910

In a previous section which described 1909 permanent track construction, it was mentioned that the carbolineum wood-block paving used in the 1907-1908 permanent construction rose from the concrete base and was, consequently, removed from Jasper and Namayo Avenues (97th Street) during that year. The problem with the blocks first became apparent during the spring thaws of 1909. When the ambient temperature rose during the day and caused some of the snow to melt, some of the melt-water entered the spaces between the blocks and collected on top of the concrete base. When the temperature dropped to below freezing, at night for example, the water beneath the blocks would freeze and expand, causing the blocks to lift. In addition, some blocks absorbed water and they swelled. After several days of this type of weather, some of the blocks would be lifted high enough to interfere with the operation of the streetcars. Since most of the lifted blocks were swollen, it was extremely difficult to push them back into place. The City Commissioners decided, therefore, that when blocks interfered with streetcar operation, they were to be removed and the resulting spaces filled with gravel. (Edmonton Evening Journal, 1909, March 15, p. 1) In the same press report (p. 1) it was stated that the City Commissioners were attempting to reach an agreement with the contractor for repairs to the pavement. No repairs were made, however, and most of the wood-block paving had been removed from Jasper and Namayo Avenues (97th Street) by the end of 1909. (CEAR, 1909, p. 97) A more permanent form of paving was necessary.

By May 1910, the snow from the previous winter was gone and track construction could be resumed. The City Commissioners had considered the problem of selecting a replacement paving and by

June 11 had settled on a type of paving that they felt would be satisfactory. The paving consisted of wire reinforced concrete with expansion joints, finished with "Bitulithic topping". (CECR No. 88, June 11, 1910) The "Bitulithic topping" referred to an asphaltic composition consisting primarily of bitumen. The actual construction started with crews first removing the gravel and any remaining wood-blocks from between the rails. Number 10 gauge expanded metal mesh was placed between the rails and a layer of concrete was then deposited on top to a height of approximately 4 inches (102 mm). In addition, the top surface of the concrete was shaped so that flangeways were formed at each rail-head with a 2 inch (51 mm) deep trough approximately 3 feet 8½ inches (1 130 mm) wide in the middle. When the concrete had hardened sufficiently, bitulithic compound was placed in the trough. The bitulithic surface, although even with the sides of the trough, was intended to have a ½ inch (13 mm) high crown between the rails so that the surface sloped towards the flangeways, thereby facilitating drainage. This new pavement replaced all wood-block pavement on ERR lines. The appearance of the new pavement may be observed in Figure 10 which is a cross-sectional drawing done for the ERR in 1910. (After City Engineers' Revised Plan, Section of Bitulithic Paving Between Tracks, August 29, 1910) Minor deletions plus the metric conversion were done by the author.

The installation of the new pavement on Jasper and Namayo Avenues (97th Street) and First (101st) Street took place throughout August and September. Crews worked on one track at a time in order to prevent the total disruption of streetcar service. (CEAR, 1910, p. 110)

Permanent Construction, 1910

The method of construction that was used in 1909 was abandoned

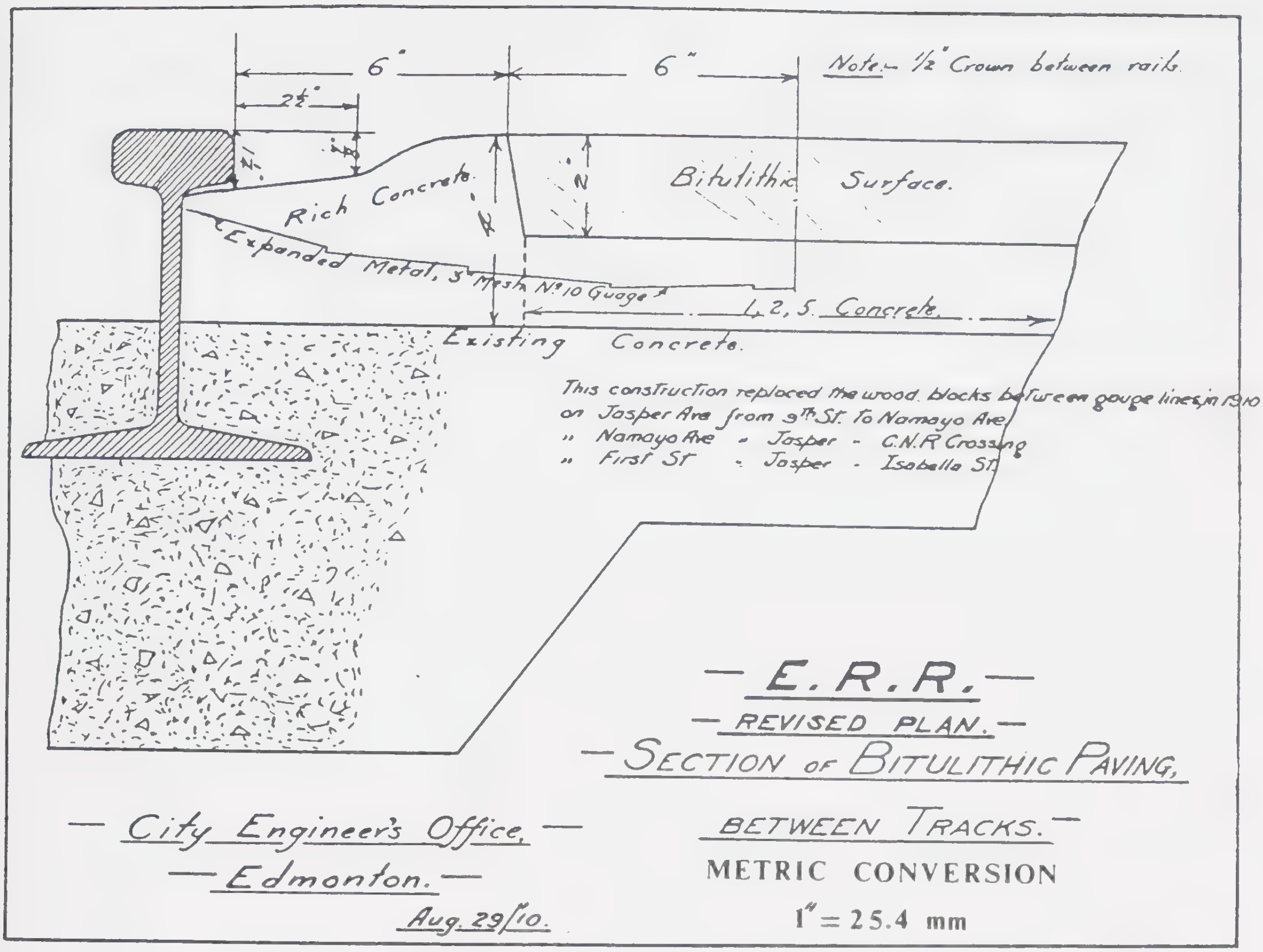


FIGURE 10.

in 1910 in favour of a different type of construction. The method of track support was the major difference between the two construction types. In the 1909 construction, a 4 inch (102 mm) thick concrete base laid on the bottom of the trench supported the tracks. In the 1910 construction, longitudinal "beams" of concrete, formed and set into the bottom of the trench and designed to lie directly under each running rail, were thought to provide better support than a uniformly thick concrete base. (CEAR, 1910, p. 90) After the trench had been excavated and after the concrete beams had hardened, wooden ties of the same dimensions and materials as those used in 1909 were placed across the beams at 2 foot (610 mm) intervals. Lengths of 80 pound per yard

(33.2 kg/m) ASCE T-rail were spiked directly to the ties. Concrete was then poured between the rails until there was an even layer covering the ties. The pavement used was one of two types. The first and most common type used consisted of concrete poured between the rails until even with the tops of the rails. Flangeways were formed in the concrete before it hardened. (CEAR, p. 90) The second type used consisted of granite paving blocks placed between the rails and in two rows along the outside edges of the tracks. Granite block paving was used on Namayo Avenue (97th Street) between the railroad crossing and Norwood Boulevard (111th Avenue). (CEAR, 1911, p. 63) A cross-section of this type of construction would resemble a cross-section of the 1907-1908 permanent construction, see Figure 3. It should be noted, however, that the spike blocks and steel ties were not used in the 1910 construction.

It has been mentioned earlier in this section that some City employees felt that the 1910 method of track construction was superior to the methods used previously. This notion was, however, the opinion of some City Engineers and the new superintendent of the ERR, C. V. Biswanger. Biswanger, who replaced C. E. Taylor in 1910, was forced to contend with rising construction and maintenance costs. While the 1910 construction was thought to have been as satisfactory as earlier construction methods, the 1910 track was less expensive to construct, since fewer materials were required. (CEAR, 1909, p. 99; 1910, pp. 68 & 84)

Only .77 of a mile (1.24 km) of permanent double-track was constructed in 1910. Map 4 (after Official Map of the City of Edmonton, 1938, and (CEAR, 1909, p. 90) shows the location of where the track was constructed. The one block section of isolated double-track on Main (104th) Street in Strathcona should be noted. This section of permanent

track was constructed in conjunction with the City of Strathcona, whose crews were paving that portion of Main (104th) Street. A double-track line on Main Street was planned for future construction and both the Strathcona City Council and the City Commissioners of Edmonton felt that it would be mutually advantageous to lay that section of permanent track while the street was being paved. (CECR No. 134, August 1910) The Main Street trackage was not connected to the line on Whyte (82nd) Avenue because special work was required. Since the pavement on Whyte Avenue had to be torn up in order to install the special work, it was decided, by the Edmonton City Commissioners, not to install the special work until the line on Main Street was to be operated. (CECR No. 134, August 1910)

Temporary Construction, 1910

Until 1910, the methods used in the construction of temporary track had not been altered significantly. In the 1909 Annual Report, Superintendent Taylor noted that the Street Railway Department was having to spend inordinate sums of money to maintain the temporary track previously laid. The high maintenance was the result of a basic flaw in the track construction. Although the track was ballasted, there was no provision made for roadbed drainage. In addition, the surrounding road was usually not gravelled. During heavy rains, or during spring thaws, the movement of the water across the unpaved roads would remove some of the ballast. Water would also remain and would accumulate below the ballast. This would soften the road, which would further undermine the track. The result of the undermining was an undulating and dangerous track that required immediate repair. (CEAR, 1909, p. 97) It had been determined by the ERR superintendent and by the

City Engineers that some provision for adequate drainage was necessary if maintenance of temporary track was to diminish. In 1910, consequently, a major change in construction was made. Once the road surface had been graded, a shallow trench was dug longitudinally along the road. The trench was placed so that when the track was laid, the trench would be located directly beneath the centre of the track. After the trench was dug, it was filled to the top with gravel or stone rubble. In addition, smaller cross-trenches or culverts were installed "where convenient" between the main trench and drainage ditches or storm sewers. (CEAR, 1910, p. 90) Upon completion of the drainage system, the track was laid using the same type of methods and materials used in previous years. The ballast that was used, however, consisted of coal cinders or gravel. Coal cinders were used because of a difficulty in obtaining suitable gravel. (CEAR, p. 100)

Although a total of 2.57 miles (4.14 km) of temporary single-track grade was prepared in 1910, only 1.48 miles (2.38 km) of track was laid and completed during that year. Delays in the arrival of materials was given as the reason for the small distance of track completed. All temporary track was constructed by City crews. (CEAR, p. 90 & p. 97) Maps 4 and 5 (both after Official Map of the City of Edmonton, 1938, and CEAR, 1910, p. 97) show the location and extent of both complete and incomplete single temporary track constructed in 1910.

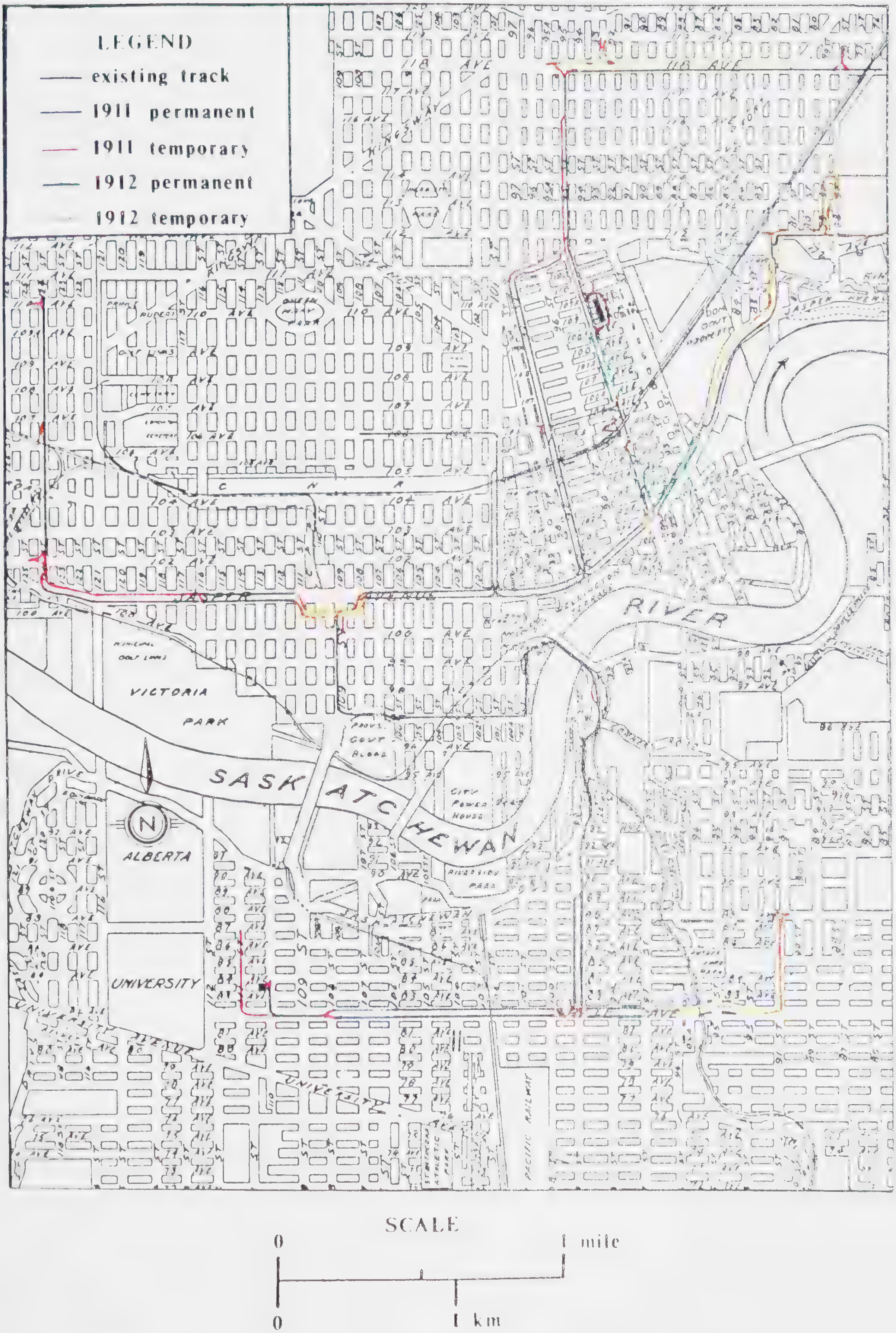
Permanent Construction, 1911

In the 1910 Annual Report, Superintendent Biswanger urged the City Council not to consider any significant extensions of permanent track in 1911. Biswanger's reason for this was an attempt to keep the ERR's deficit from rising substantially. (P. 111) Biswanger was replaced

by R. Knight in January 1911. (Edmonton Bulletin, 1911, January 30, p. 1) Knight shared Biswanger's concern over the deficit. Only .24 of a mile (0.39 km) of permanent double-track was constructed. (CEAR, 1911, p. 60) The construction replaced temporary track; no new extensions were built. (CEAR, p. 63) The distance constructed was the shortest length of permanent track constructed in any year since the start of construction in 1907. City crews as well as contractors constructed the permanent double-track, which was located on Whyte (82nd) Avenue between 2nd Street West and 4th Street West (106th Street and 108th Street) in Strathcona. (CEAR, p. 63) Map 6 (after Official Map of the City of Edmonton, 1938, and CEAR, 1911, p. 63) shows the location of permanent double-track constructed during 1911.

Temporary Construction, 1911

It was mentioned in the last section that in 1910, Superintendent Biswanger recommended that extensions of the ERR be kept to a minimum in order to reduce the growth of its deficit. Biswanger did recommend, however, that some temporary track be constructed. Most of the temporary construction was intended to provide a second track for some roads where only a single track had existed. (CEAR, 1910, pp. 111-112) In addition, the ERR ordered several single-end streetcars (streetcars that could be operated from one end only) in 1910. (CEAR, p. 8) In order to operate the single-end streetcars correctly, loops or Y's (wyes) had to be constructed at the termini of lines, or wherever it was deemed necessary for a streetcar to return along its route. To accommodate the single-end streetcars, therefore, Superintendent Biswanger recommended that six wyes be constructed at various points along the system. (CEAR, p. 112)



MAP 6. EXTENT & TYPE OF CONSTRUCTION
1911 - 1912

City crews first completed the track that was begun in 1910. Work was then started on new sections. A total of 1.8 miles (2.9 km) of new track was constructed in 1911, all of it laid along streets that had a single temporary track. (CEAR, 1911, p. 63) In addition, several wyes were constructed, including one at the Strathcona car barns, to enable the single-end streetcars to be operated properly. (Letter from Secretary-Treasurer, City of Strathcona, to City of Edmonton Commissioners, April 26, 1911)

In the fall of 1911, the Cities of Strathcona and Edmonton agreed to amalgamate. By December, the Provincial Legislature gave its approval to the Edmonton-Strathcona Amalgamation Act. (Statutes of Alberta, 1911-1912, Chapter 66, pp. 524-531) While the Act stated that Strathcona would lose its name, the Act also stipulated that all present streetcar lines in Strathcona would be retained. In addition, the Act described certain extensions of existing streetcar lines that had to be constructed and completed in Strathcona by either December 31, 1912 or by February 1, 1914. (Statutes of Alberta, 1911-1912, Chapter 66, pp. 524-531) One of the extensions described was a line that was to be built from somewhere along Whyte (82nd) Avenue north to the University of Alberta. The location and routing of the extension was to be determined by the University Board of Governors and by the Strathcona City Council. (Statutes of Alberta, 1911-1912, Chapter 66, p. 529) It was ultimately decided to extend the existing single-track line on Whyte (82nd) Avenue one block west to Seventh (111th) Street, then north along Seventh Street to Fifth (87th) Avenue. The total length of the extension was .47 of a mile (0.77 km). (CEAR, 1911, p. 63, and Mundy's Street Index Map to Edmonton, 1912) The location of all temporary track, wyes and sidings (sometimes referred to as turnouts) constructed in 1911 may be seen

on Map 6. (After Official Map of the City of Edmonton, 1938, CEAR, 1910, p. 112; 1911, p. 63, and ERR plans showing rail and rail returns, 1912)

Permanent Construction, 1912

In the 1911 Annual Report, Superintendent Knight stated,

> The maintenance of the ballasted [temporary] track has been an exceptionally heavy item in this year's operation, . . . future extensions should be largely constructed on a finished and permanent basis. The comparative lives of ballasted and paved track have been given as five and twenty years respectively, thereby necessitating the rebuilding of the ballasted track three times during the latter period. (p. 150)

Knight also cited maintenance costs of both track and rolling stock as further reasons to construct permanent track rather than temporary track. As was the practice in 1911, permanent track was constructed on streets where single or double temporary tracks had been laid previously. The concrete girder or concrete beam design of construction that was introduced in 1910 was used through 1912. (CEAR, 1913, p. 132) In addition, several pieces of special work were ordered during 1912 for delivery and installation in 1913. It should be noted that no permanent special work had been installed since 1908. (CEAR, p. 286) The largest and most unusual piece of special work ordered was a double-track "grand union" that was to be installed in the intersection of Jasper Avenue and Ninth (109th) Street. (Hadfields Steel Foundry blueprint showing layout and construction procedure of special work at Jasper Avenue and Ninth Street, 1912) A detailed description of this item may be found in a subsequent section that deals with permanent construction in 1913.

A total of 1.35 miles (2.17 km) of permanent double-track was constructed in 1912, all of it replacing temporary track. (SRDMR, January-December 1912) In addition, .48 of a mile (0.77 km) of single

permanent track was constructed in the southern part of Edmonton (formerly Strathcona) along the west side of Fifth Street East (99th Street) from Whyte (82nd) Avenue to Seventh Avenue North (89th Avenue). (CEAR, 1912, p. 206) It should be noted that the construction of the single permanent track on Fifth Street East (99th Street) took place without the total disruption of streetcar service since the temporary track was located on the east side of the street. It should also be remembered that, in a previous section which described temporary construction in 1908, the ease of future construction was given as a possible reason for the placement of temporary track near a side of a road. It appears, therefore, that from the construction procedures of 1912, some temporary track was placed near the sides of certain roads in order to facilitate the construction of permanent track at some future time.

Map 6 (after Official Map of the City of Edmonton, 1938, and (CEAR, 1912, p. 206) shows the location of permanent track constructed during 1912.

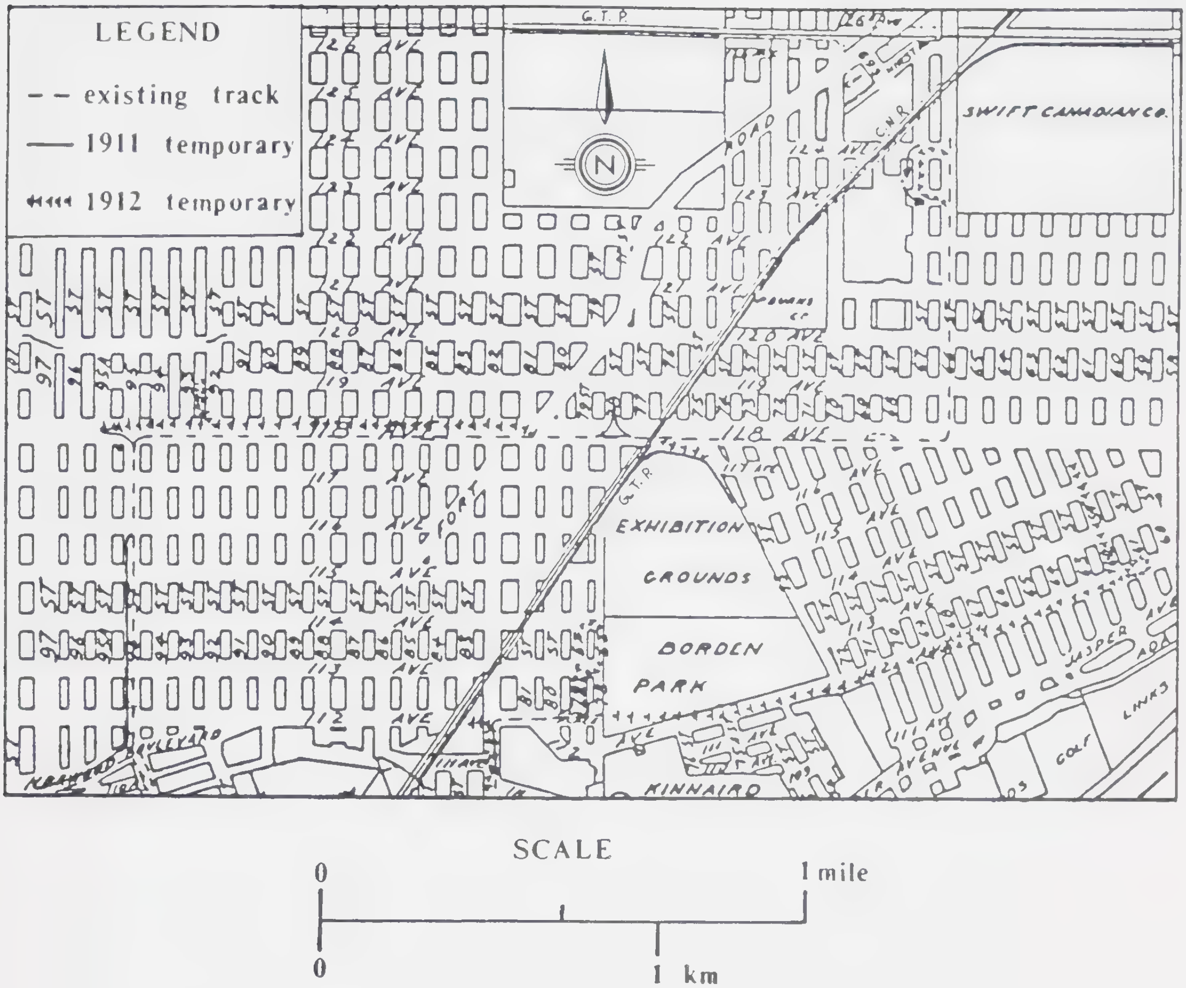
Temporary Construction, 1912

Most of the track constructed consisted of new extensions to the system. A single-track line was built along Whyte (82nd) Avenue from Seventh Street East (97th Street) to Eleventh Street East (91st Street), where it turned north onto Eleventh Street and terminated at Sixth Street North (88th Avenue). (CEAR, p. 206) This particular line was constructed to fulfill one of the requirements described in the Edmonton-Strathcona Amalgamation Act. (Statutes of Alberta, 1911-1912, Chapter 66, p. 529) An additional extension was built in Edmonton. Starting at the East End (Borden) Park, it travelled east through the park to Pine (112th) Avenue and continued east along Pine and Knox (112th) Avenues to

Campbell (61st) Street in the Highlands district, where it terminated. (CEAR, 1912, p. 206, and Mundy's Street Index Map of Edmonton, 1912) Although the ERR constructed the Highlands extension, the construction costs were underwritten by the Magrath-Holgate Company, a land development firm. The only exception to this was the portion of the line constructed in the East End (Borden) Park. (CEAR, 1912, p. 206) The remainder of the track constructed in 1912 consisted of turning loops, sidings and two sections of single-track which provided second tracks where they were laid. One track was constructed along Alberta (118th) Avenue between Kirkness and James (95th and 81st) Streets. The other track was built along Jasper Avenue, Kinnaird (82nd) Street and Pine (112th) Avenue, from the Penitentiary (Latta) Bridge to the East End (Borden) Park. (CEAR, p. 206)

In addition to the track already described, a temporary double-track diversion was constructed south of Jasper Avenue between Eighth and Eleventh (108th and 111th) Streets in early August. This diversion, which travelled along a lane between Jasper and Victoria (100th) Avenues, was intended to maintain streetcar service while crews removed the existing tracks on Jasper Avenue between Eighth and Eleventh Streets, and then prepared that section of Jasper Avenue for both a Canadian Pacific Railway (CPR) overpass and for the grand union that was mentioned in the previous section. (SRDGL, Account C4T, and Edmonton Capital, August 5, 1912)

Maps 6 and 7 (both after Official Map of the City of Edmonton 1938, CEAR, 1912, p. 206, and SRDGL, Accounts C4A-C4B) show the location and the extent of temporary track constructed in 1912.



MAP 7. NORTHEAST CONSTRUCTION, 1911-1912

Freight Track, 1912

It appears that several businesses in Edmonton became interested in being served by the ERR. Apart from being able to construct tracks to the premises of individual businesses, the ERR was also able to transport various pieces of freight and equipment from the steam railroads to the various city businesses. The ERR had two interchanges with steam railroads in 1912. One was with the Grand Trunk Pacific Railway (GTP), at their spur adjacent to Alberta (118th) Avenue. To connect the two railways, the ERR built a small spur between Phillips and Robertson (76th and 74th) Streets which travelled south from Alberta (118th) Avenue and connected with the GTP spur. (ERR Drawing showing Plan of Spur

Connecting E.R.Ry. Alberta Ave. & G.T.P.Ry. Exhibition Spur, 1912) The other interchange was with the Canadian Northern Railway (CNOR). The location of this interchange was in the northern part of the City yard, which was located between Kinistino and Syndicate Avenues (96th and 97th Streets), immediately south of Griesbach Street (105A Avenue). (Mundy's Street Index Map to Edmonton, 1912, and CEAR, 1912, p. 207) The ERR constructed a spur into the north yard from Syndicate Avenue (95th Street), between June and July 1912. (SRDGL, Account C4P) A total of three freight spurs were constructed in 1912 to various businesses in Edmonton. The businesses were: Rendall, MacKay and Michie, sash and door manufacturers, located on the south side of Wilson Street (110th Avenue) between Syndicate and Ottawa Avenues (95th and 93rd Streets); C. F. Taylor lumber yard, located on the north side of Alberta (118th) Avenue between Lorne and Kennedy (92nd and 93rd) Streets; Alsip Brick and Supply Company, located at the intersection of Pine (112th) Avenue and Kinnaird (82nd) Street. (SRDGL, Accounts C4M-C4Q, and Henderson's Edmonton City Directory, 1914) Plate 7 (Glenbow Archives) shows the appearance of the C. F. Taylor spur sometime during 1912 or 1913. The presence of railroad boxcars on the spur as well as the temporary track construction should be noted. The other piece of rolling stock on the spur was the ERR's motorized work/flat car. It will be discussed in a subsequent chapter.

In addition to the three freight spurs constructed, a special spur was built along Grace (62nd) Street from the Highlands passenger line on Knox (112th) Avenue, to a point immediately south of Alberta (118th) Avenue. The spur, which was 1,000 feet (304.8 m) long, was constructed for the sole purpose of transporting materials and supplies for the construction of the Edmonton Public School Board's new Highlands School, located

Plate 7. (Glenbow Archives) Taylor Spur and Work Car Number 4

on the west side of Grace (62nd) Street, south of Alberta (118th) Avenue. (Edmonton Journal, November 14, 1917, p. 2, and Henderson's Edmonton City Directory, 1913) The construction of this spur emphasized the fact that the ERR had a vital part in the movement of freight within the City before the development of high capacity road vehicles. The spur was not used after the completion of the Highlands School. (Edmonton Journal, November 14, 1917, p. 2)

The location of all spurs constructed during 1912 may be seen on Maps 6 and 7.

Block Signals, 1912-1913

By 1912, most of the heavily used lines were double-tracked. A notable exception was the long single-track section that began at Ninth (109th) Street and Victoria (100th) Avenue, and ended at Fifth Street East (99th Street) and Seventh Avenue North (89th Avenue). (See Map 6) Although several passing sidings had been constructed, streetcar operation along this particular section was more difficult than along other sections of single-track. This single-track section, unlike most other single-track sections on the ERR, was very long and encountered several sharp curves and steep grades. The grades and curves effectively obscured portions of the track located between passing sidings. When a streetcar reached a siding or the end of the double-track, it usually had to wait for the streetcar travelling in the opposite direction to vacate that single-track section. Problems arose, however, if the streetcars happened to be delayed. If a streetcar arrived at a siding or at the end of the double-track far behind schedule, the motorman, upon observing a seemingly clear track, could assume that the streetcar travelling in

the opposite direction had already been through that single-track section. If the motorman's assumption was wrong, the other streetcar being on an obscured portion of the track, the streetcars would meet somewhere along the single-track. One streetcar would have to back along the track until a siding or the double-track was reached. Conversely, a streetcar could wait at a siding or at the end of the double-track until the motorman saw the other streetcar pass. If, however, the other streetcar had been delayed for a long period of time, the waiting streetcar would fall behind schedule and would also delay other streetcars behind it. These problems were common along this section of track since the start of service in 1908. (Edmonton Bulletin, December 28, 1911, p. 8)

There were many suggestions from the general public on how to eliminate the problem. The suggestions ranged from installing telephones or signals at either end of the single-track sections to installing more sidings. (Edmonton Bulletin, May 31, 1912, p. 2) No action took place, however, until the new Superintendent, W. T. Woodroofe, took charge of the system in July 1912. (Edmonton Journal, July 4, 1912) After travelling the ERR, Woodroofe decided that a signal system was required if the safety and speed on the long single-track linking the northern and southern parts of Edmonton was to improve. (Edmonton Capital, September 7, 1912)

In the operation of single-track steam railroads, the track was divided into operational sections called "blocks". Each block was protected at either end by signals referred to as "block signals". (Harding & Ewing, 1926, p. 243) The signals usually showed the condition of the block, occupied or vacant, by displaying colored lights and some other form of indicator. The signals could either be controlled manually or automatically.

The ERR divided the single-track section into three blocks and installed signals at both ends of each block. (Edmonton Bulletin, September 23, 1912, p. 2) One block started at the end of the double-track on Ninth (109th) Street at Victoria (100th) Avenue and ended at the siding on Saskatchewan (97th) Avenue. The next block was located between the Saskatchewan Avenue siding and the siding on Currie (100th) Street. The final block was located between the siding on Ross (Strathcona) Road and the start of the double-track on Fifth Street East (99th Street) at Seventh Avenue North (89th Avenue). (ERR Drawing of Rail Returns, June 1912) Plate 9 (Glenbow Archives) shows the signal that was installed at the southern end of the Ross Road block near Eighth Avenue North (90th Avenue). Harding & Ewing (1926) describe this type of signal and its operation. The signal employed three colored lights and three movable colored discs to indicate the status of the block. Each signal could display three indications: (1) neutral, if no streetcar was in the block, no lights or discs would be visible; (2) permissive, if an approaching streetcar entered the block, only if the signal indicated neutral, the signal would display two white lights and two white discs, indicating that it was safe to proceed and that the other signal indicated stop; (3) stop, a red light and a red disc were visible, indicating that a streetcar was already in the block and that the approaching streetcar would have to wait clear of the single-track until the signal displayed a neutral indication. (pp. 253-254) The signals were activated by an electrical contactor installed on the overhead (trolley) wire a few yard (metres) before each signal. As a streetcar approached one of the signals, its trolley wheel would touch the contactor. This action closed an electrical circuit to a relay which turned the signals on and which set the indications of each one. When the streetcar left the block, the trolley wheel would touch the

other contactor. This action would cause the relay to open, shutting off the signals, thus presenting a neutral indication. The signals and contactors were interconnected by overhead wires that were strung on poles that were located along the side of the road. (Harding & Ewing, pp. 252-256) The overlay for Plate 9 indicates the contactor and the discs of the signal. It should be noted that the signal is displaying a permissive indication. The combination sweeper and baggage streetcar can, therefore, proceed through the block without meeting another streetcar travelling in the opposite direction.

The block signal system was short-lived. By the end of 1913, permanent double-track had been constructed from Victoria (100th) Avenue to a point on Currie (100th) Street near the northern end of the Low Level Bridge. In addition, permanent double-track was constructed along Fifth Street East (99th Street) to Ross (Strathcona) Road, and along Ross Road to Eleventh Avenue North (93rd Avenue). (CEAR, 1913, p. 286; see Map 8) The double-track construction eliminated two single-track blocks entirely and eliminated an obscured portion of the track in the Ross Road block. The block signal system had become superfluous. It was removed during 1913, stored and later disposed of as surplus material. (CECR No. 211, October 1, 1915)

Permanent Construction, 1913

It was mentioned previously, in the section describing 1912 permanent construction, that Superintendent Knight recommended that new extensions to the system be of permanent construction in order to reduce track and rolling stock maintenance costs. (CEAR, 1911, p. 150) Knight's recommendation was continued by his successor, W. T. Woodroofe, who stated in January 1913 that, "It is the intention this year to replace

all temporary unballasted track with permanent track, thus cutting down this item almost entirely." (CEAR, 1912, p. 205 & p. 207) The replacement of temporary track by permanent construction had begun, to some extent, during 1912 with the construction of the Jasper Avenue diversion and with the ordering of the grand union for the intersection of Ninth (109th) Street and Jasper Avenue. In addition to these actions, the City Council had given its approval in December 1912 to a grandiose track construction plan formulated by an Inspector Moir of the ERR. Moir's plan, if completed, would have provided the ERR with a total of 150 miles (241.4 km) of permanent double-track; distance reckoned as single-track. (Canadian Railway and Marine World, January 1913, p. 39) While Moir's plan called for 18 single-track miles (29 km) of permanent double-track to be built in 1913, the actual distance of permanent track built in 1913 was 21.71 miles (34.9 km). This distance, which included both single and double construction, was calculated as single-track. (CEAR, 1913, pp. 285-286) It may be asked why there was such a large expansion of the ERR's permanent trackage in 1913 considering the economic constraints of previous years. In addition to Superintendent Knight's premise that permanent track would ultimately reduce maintenance costs, the population of Edmonton as well as ridership on the ERR had been increasing greatly. In the 1912 Annual Report, it was indicated that ERR ridership for that year was more than double the ridership of 1911. (P. 14) It was the general concensus of most City officials that the population would continue to increase at a rapid rate. In view of increasing population and ridership, it was thought that large extensions to the ERR were indispensable if the street railway was to serve Edmontonians adequately. (CEAR, pp. 1-14 & p. 208)

An entirely new method of permanent construction was adopted

in 1913. It had been found that the concrete beam or concrete girder construction of 1910-1912, while relatively inexpensive to construct, was subject to rapid disintegration from the vibrations caused by passing streetcars. It was stated in an article written by H. C. Saunders, a Construction Engineer of the ERR that,

> It was found that the vibration of the rail directly against the concrete caused a gradual crumbling away of the top and sides of the [concrete] girder, so that the rails were ultimately balanced upon a knife edge of concrete. . . . cases were noted where the rail had settled 4in. and 5in. [102 mm and 127 mm] below the paving, necessitating constant repair and expensive shimming. In view of this experience the base type of construction was adopted. (Edmonton Official Gazette, July 2, 1914, p. 255)

The "base type" or "concrete slab construction", as it was usually referred to, supported the track by means of a 6 inch (152 mm) thick layer of concrete laid on a prepared subgrade. (CEAR, 1913, p. 132 & p. 286) The subgrade usually consisted of a trench excavated along the centre of the road. The trench was dug to a depth of approximately 10 inches (254 mm) below the graded surface of the road, the sides of the trench sloping 45° from top to bottom. The width of the trench for double-track, measured across the top of the trench, was either 22 feet 2 inches (6 756 mm), or 20 feet 6 inches (6 248 mm). The width used depended upon whether the centres of the two tracks were to be 12 feet (3 658 mm) apart, or 10 feet (3 048 mm) apart. The track centre distance was determined by the overall width of the road where the tracks were to be laid. If a single-track was to be constructed, the width of the trench, measured across the top, would be approximately 10 feet (3 048 mm). (CEED, Drawings S.R.13 #1 & S.R.13 #2, February 22, 1913) When the excavation of the trench was complete, the bottom was packed by a 10 ton (9 072 kg) steam roller. A 6 inch (152 mm) layer of concrete was then deposited along the bottom of the trench.

It should be noted that no metal reinforcing of any kind was used in that layer. (CEED, Drawings S.R.13 #1-S.R.13 #4, February 22, 1913) A sand cushion of approximately 1 inch to 2 inches (25.4 mm to 50.8 mm) was deposited on the concrete when it had hardened, but only where the ties would be placed. The purpose of the sand was to provide resilience to the track. In addition, the sand assisted with the alignment of the track since the ties tended to slide easily along the sand. Wooden ties of the same size and materials used previously were laid along the sand-covered concrete at intervals of 2 feet (610 mm), measured centre to centre. Lengths of 80 pound per yard (33.2 kg/m) ASCE T-rails were then placed directly on the ties. (CEAR, 1913, p. 286)

A dispute arose between Superintendent Woodroofe and the City Engineers. The Engineers, who collaborated with the ERR on track construction, wanted to use steel tie plates between the rails and the ties. A tie plate was a flat piece of steel that could be placed under the rails on each tie. The purpose of a tie plate was to distribute the weight of the rail over a large area of the tie, thereby increasing its life, since the likelihood of the rail cutting into the tie would be reduced. (Doane & Parkham, 1926, § 19, p. 9) The Engineers, therefore, ordered a large quantity of tie plates. Superintendent Woodroofe, however, believed that tie plates on a street railway were superfluous since the weight of the streetcars and rails were much less than the weights of the rail and equipment used on the main lines of most steam railroads where tie plates were most frequently used. Woodroofe prevailed and the tie plates were not used. (CECR No. 211, October 1, 1915) Woodroofe was later blamed for the premature failure of some 1913 permanent track in 1915 (CECR No. 248, November 29, 1915)

After being placed on the ties, the lengths of the rail were joined

together by means of "continuous joints". (CEAR, 1913, p. 286) Until 1913, rails on the ERR had been joined by means of plain angle bars, also known as fishplates, channel plates or joint plates. Angle bars were cast or forged steel plates that were placed on both sides of the rail. Most angle bars fitted between the bottom of the rail head and the top of the rail foot. In addition, angle bars had holes drilled through them, usually four, to allow track bolts to pass through. In usual practice, one half of the angle bar was bolted to the end of one rail section, the other half being bolted to the adjoining rail. Angle bars were made in different sizes to accommodate the various heights of rail. (Doane & Parkham, 1926, § 19, p. 19) Some plain angle bars are visible in Plates 5 and 6. While the plain angle bar prevented the rail sections from separating, they did little to control vertical movement and bending of the rail at the joints. It should be remembered that in ERR construction, the joints themselves were placed between individual ties. See the section on 1908 temporary construction for further elaboration. A continuous angle bar consisted of a standard angle bar with an integral base which resisted vertical movement of the rail. Figure 11 (after drawing by the Rail Joint Company of Canada, showing a continuous rail joint, and Doane & Parkham, 1926, § 19, p. 19) shows a complete continuous rail joint as applied to ASCE-section T-rail.

When the rail sections had been joined, the rails were gauged, aligned and then spiked to the ties. Concrete was deposited between the rails until the tops of the ties were covered. Between the outside rails and the sides of the trench, concrete was poured until it was about level with the bottom of the railheads. (CEED, Drawing of Cross Section of Street Railway Shewing Method of Paving Between the Gauge, April 1913) Plate 8 (Glenbow Archives) illustrates the appearance of the

Plate 8. (Glenbow Archives) Constructing Permanent Track on Kirkness Street, 1913

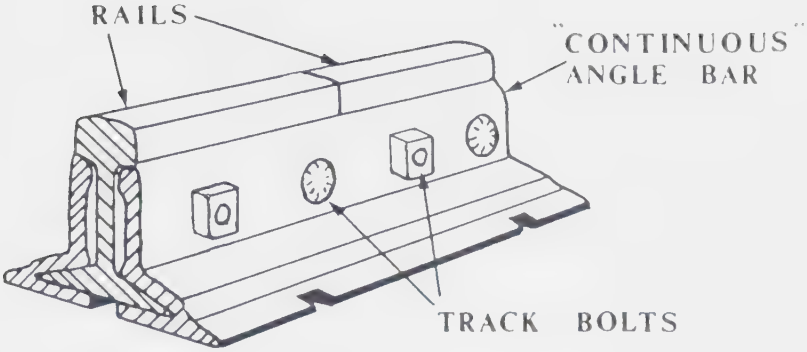


FIGURE 11. CONTINUOUS RAIL JOINT

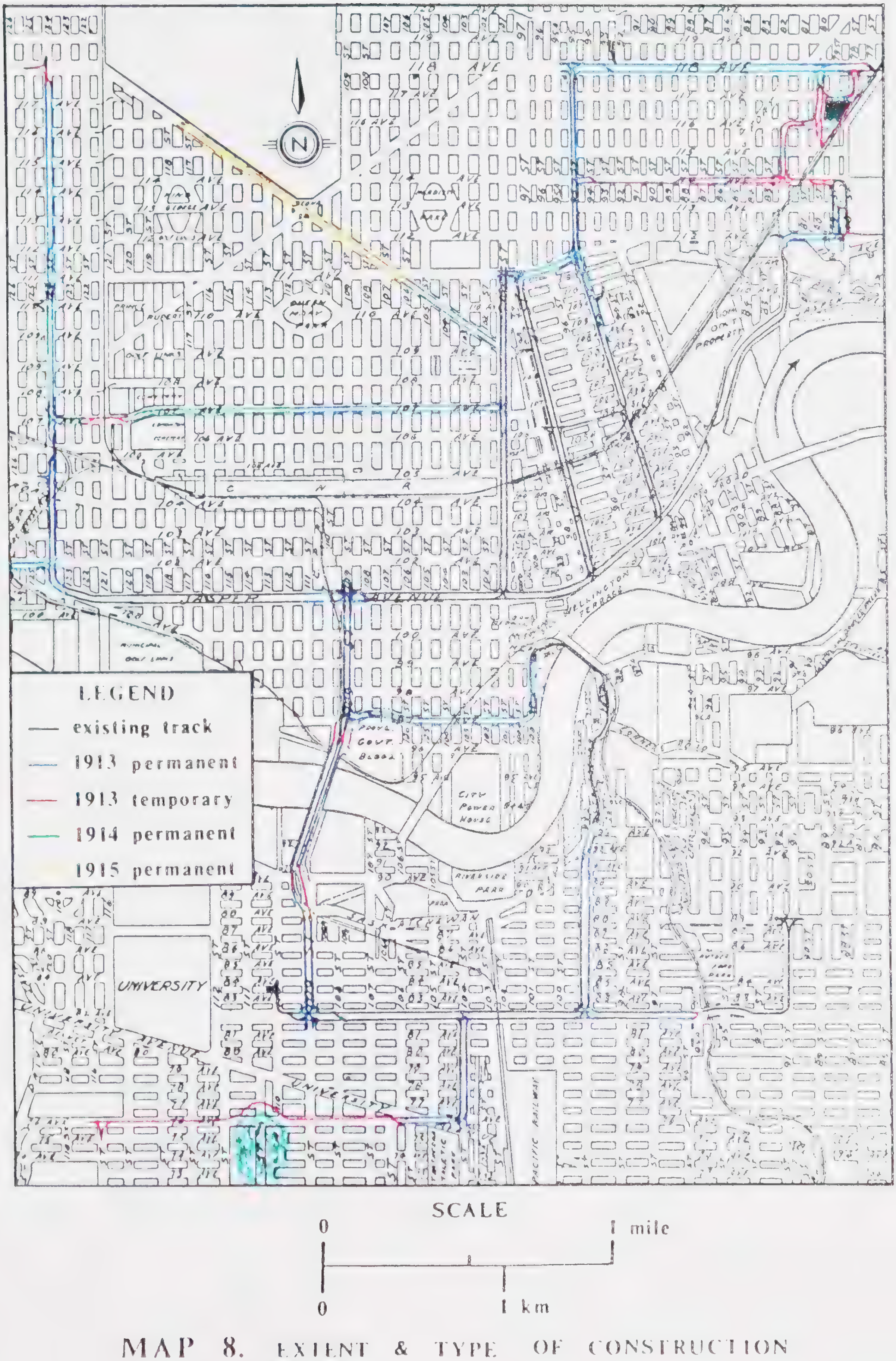
construction to this point. The photographer was facing north on Kirkness (95th) Street between Oak (116th) and Beech (117th) Avenues. Only one permanent track is being constructed at a time in order to prevent total disruption of streetcar service. The track on the extreme left is a temporary siding (turnout). In constructing the pavement between the running rails, crews first laid down a layer of Number 10 gauge expanded metal mesh. Concrete was then deposited between the rails until level with the tops of the rail heads. Before the concrete hardened, flangeways were formed and the surface of the concrete was scored to resemble paving blocks. (CEAR, 1913, p. 132) Plate 9 (Glenbow Archives) shows the appearance of some 1913 concrete paving. The photograph was taken on Ross (Strathcona) Road immediately south of Eleventh Avenue North East (93rd Avenue). The photographer was facing south. The checked surface of the concrete should be noted. The temporary track on the left was the original interurban line between Edmonton and Strathcona constructed in 1908.

The distance of permanent track constructed in 1913 was more than double the distance of permanent track constructed between 1907

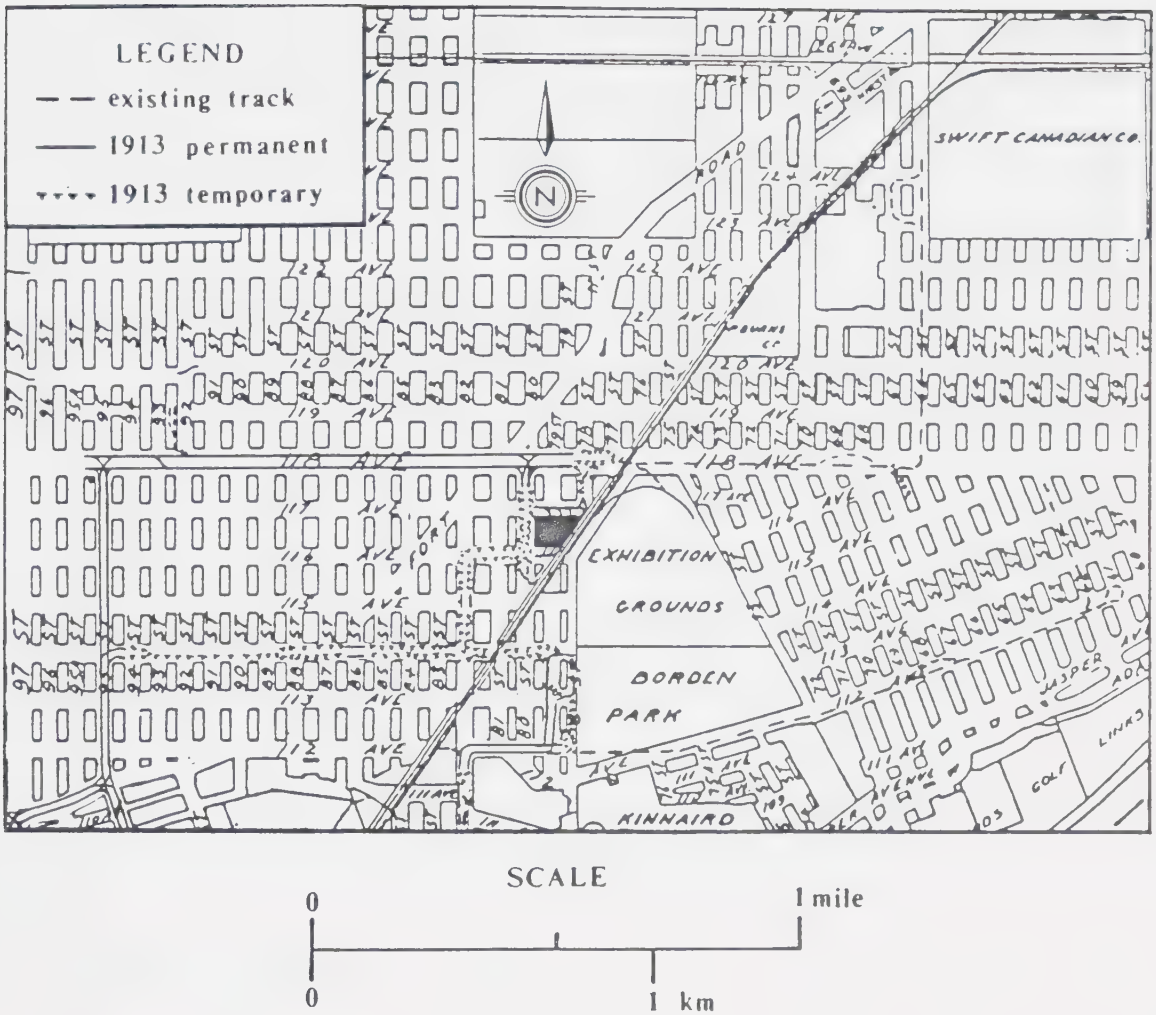
Plate 9. (Glenbow Archives) Signal and Construction on Ross Street, 1913

and 1912. A total of 21.714 miles (34.9 km) of permanent track, measured as single-track, was constructed during 1913. Of this distance, 1.495 miles (2.41 km) was permanent single-track. (CEAR, 1913, pp. 285-287) Maps 8 and 9 (both after Official Map of the City of Edmonton, 1938, and CEAR, 1913, pp. 285-287) show the location of the permanent track constructed in 1913. It should be noted that the double-track line built across the new High Level Bridge was not paved, nor were the immediate approaches. The tracks were laid on the top deck of the bridge on either side of the CPR track. No traffic besides streetcars and trains was allowed on the top deck. (ERR Drawing Showing Plan of Approaches to the High Level Bridge, 1913, and ERR Sketch Showing Cross-Section of Top Deck of High Level Bridge, 1913) Special large ties were used to support the rail. They were 10 feet (3 048 mm) long, 9 inches (22.9 mm) thick and 6 inches (152 mm) wide. (ERR Sketch Showing Cross-Section of Top Deck of High Level Bridge, 1913) The ties were placed directly on the bridge. A wooden stringer was placed near each end of the ties. These 6 inch square (152 mm X 152 mm) stringers, which ran perpendicular to the ties, were bolted to every third tie and were intended to prevent shifting of the ties. (ERR Sketch Showing Cross-Section of Top Deck of High Level Bridge, 1913, and Provincial Archives of Alberta photograph A.4708) Every third tie not bolted to the stringers was bolted to the steel work of the bridge. (Provincial Archives of Alberta photograph A.4708) Running rails were then laid on top of the ties. The rails, 80 pound per yard (33.2 kg/m) ASCE T-rails, were first centred on the ties. The rails were then aligned to the proper gauge and then spiked to the ties. It appears that continuous rail joints were not used. (Provincial Archives of Alberta photograph A.4708)

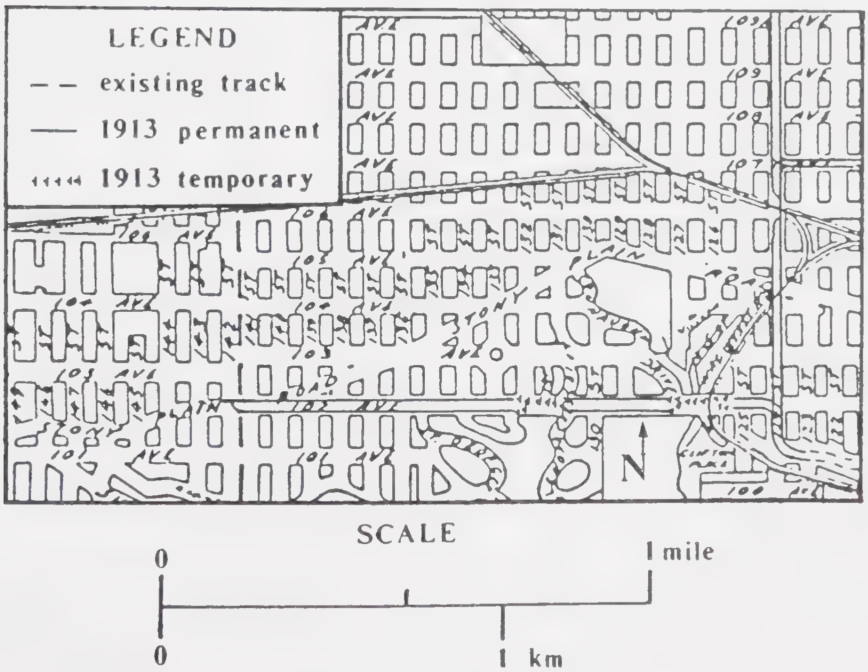
A second set of rails was laid between the running rails. This



MAP 8. EXTENT & TYPE OF CONSTRUCTION 1913 – 1915



MAP 9. NORTHEAST CONSTRUCTION, 1913



MAP 10. WESTERN CONSTRUCTION, 1913

second set was usually laid with old 60 pound per yard (24.9 kg/m) rail and was intended to act as a guard, preventing a streetcar from rolling off the bridge should it derail while crossing. (ERR Sketch Showing Cross-Section of Top Deck of High Level Bridge, 1913) The approaches to the bridge were initially built so that streetcars travelled across in the same manner in which they travelled along the street; the left hand track for south-bound streetcars, the right hand for north-bound. (ERR Drawing Showing Plan of Approaches to the High Level Bridge, 1913) This arrangement was unsatisfactory for single-end cars. These had doors only on the right side. If there was a derailment or similar emergency, the passengers could not leave by the doors because the steps would extend over the river below.

The year 1913 marked the first time since 1908 that permanent special work was installed in Edmonton. (CEAR, p. 286) In the section describing permanent construction in 1912, it was mentioned that several pieces of special work were ordered for 1913 delivery, the largest being a double-track grand union. A "grand union" may be defined as a unit of special work which enabled a streetcar, entering an intersection from any one of the four directions, to proceed either through the intersection or to make a right hand or a left hand turn. Figure 12 (after Hadfields Steel Foundry blueprint showing layout and construction of special work at Jasper Avenue and Ninth Street, 1912) shows the appearance, in plan view, of the grand union at Ninth (109th) Street and Jasper Avenue.

The grand union was manufactured in Sheffield, England by Hadfields Steel Foundry and was shipped to Edmonton in pieces. The rails used in the construction were D.K. 96c. (Hadfields Steel Foundry blueprint of special work at Jasper Avenue and Ninth Street, 1912) In addition to the grand union, twenty-eight other pieces of special work were

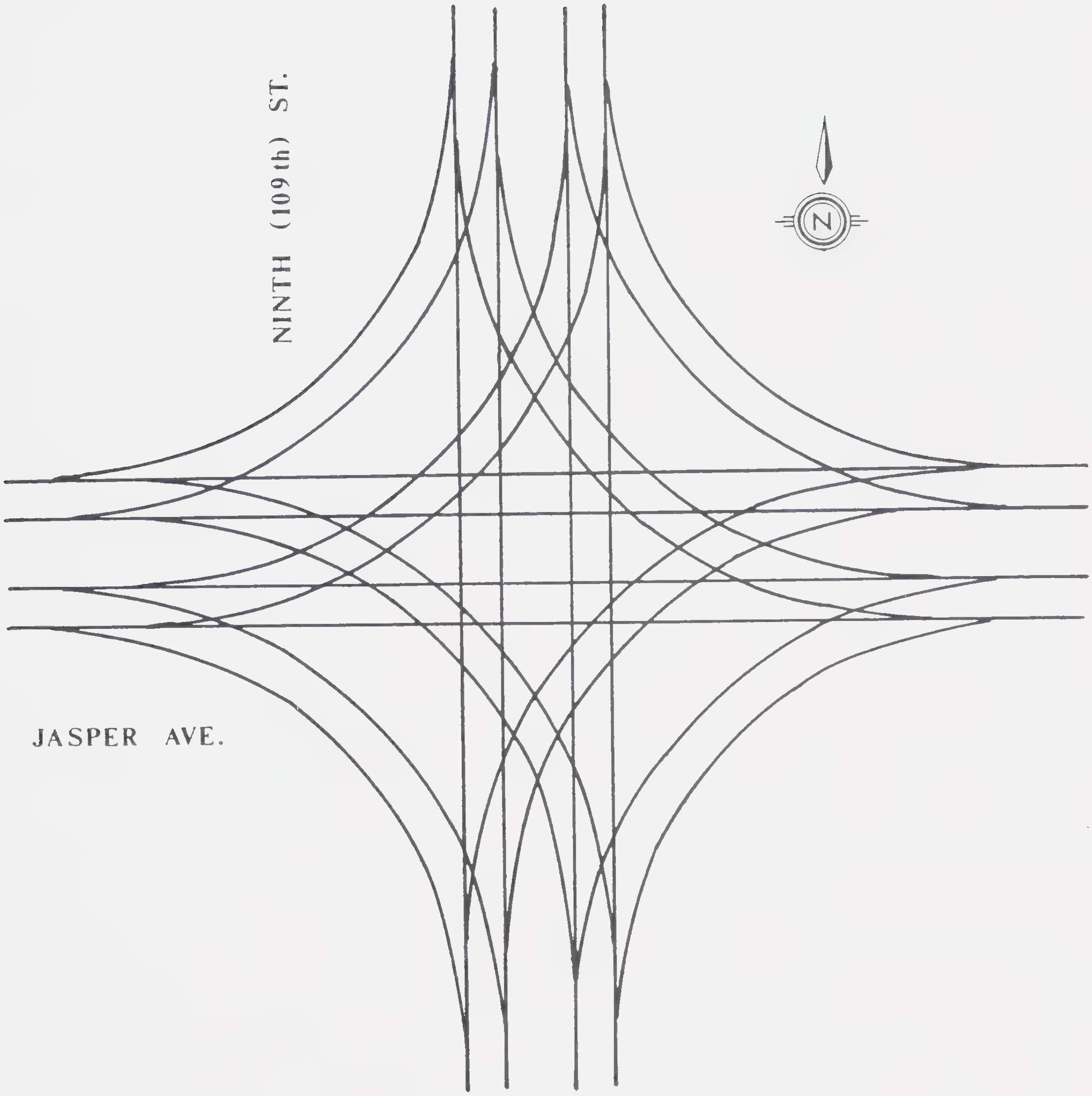


FIGURE 12. PLAN OF GRAND UNION

installed during 1913. (CEAR, 1913, pp. 286-287) Apart from the grand union and one double-track right hand branch-off, which were manufactured by Hadfields Steel Foundry, all other 1913 special work was manufactured by the Lorain Steel Company of Johnstown, Pennsylvania. (Lorain Steel Company blueprints) Table 1 (after CEAR, 1913, pp. 286-287) describes the location and type of each piece of permanent special work installed in 1913. The rail used in the Lorain special work was type 108-398 grooved girder guard rail. (Lorain Steel Company blueprints) The use of grooved girder guard rails explains why the ERR ordered prepared curves for several locations. It was mentioned previously that most street railways did not have the equipment to bend grooved girder guard rail properly. Most of the special work types mentioned in Table 1 have been described in previous sections. There are, however, two types of special work that require elaboration; the three-part through Y and the "car barn special".

A three-part through Y consisted basically of a standard three-part Y combined with a crossing so that a streetcar could proceed through the three-part through Y from any one of four directions without having to make a right hand or left hand turn. Figure 13 (after Lorain Steel Company blueprint of the three-part through Y at 5th Street West and Whyte Avenue, 1913) shows the plan view of the three-part through Y installed at the intersection of 109th Street and 82nd Avenue. Although Table 1 lists two three-part through Y's, they were never fully used since the lack of connecting tracks enabled them to be used only as standard three-part Y's. (ERR Drawing of track system, April 1920) The other term in need of elaboration is the "car barn special". The ERR constructed a new north-side car barn on Beech (117th) Avenue in 1913. In order for streetcars to enter the various car barn tracks

Table 1 Double-Track and Single-Track Special Work Installed in 1913

Double-track Special Work

Type	Location
Grand Union	Jasper Avenue and 9th (109th) Street
Three-part Y	Alberta (118th) Avenue and John (80th) Street
Three-part Y	Alberta (118th) Avenue and Kirkness (95th) Street
Three-part Y	Norwood Boulevard (111th Avenue) and Kirkness (95th) Street
Three-part Y	Ist (101st) Street and Nelson (107th) Avenue
Three-part Y	Norwood Boulevard (111th Avenue) and Namayo Avenue (97th Street)
Three-part Y	24th (124th) Street and Short (107th) Avenue
Three-part Y	Saskatchewan (97th) Avenue and 9th (109th) Street
Three-part Y	5th Street East (99th Street) and Whyte (82nd) Avenue
Three-part Y	Main (104th) Street and Whyte (82nd) Avenue
Three-part Through Y	Norwood Boulevard (111th Avenue) and 1st (101st) Street
Three-part Through Y	5th Street West (109th Street) and Whyte (82nd) Avenue
Right Hand Branch-off	Kirkness (95th) Street and Spruce (114th) Avenue
Right Hand Branch-off	Main (104th) Street and 6th Avenue South (76th Avenue)

Left Hand Branch-off	Pine (112th) Avenue and Agnes (79th) Street
Left Hand Branch-off	Athabasca (102nd) Avenue and 24th (124th) Street
Curve	Kinnaird (82nd) Street and Pine (112th) Avenue
Curve	Jasper Avenue and 24th (124th) Street
Curve	Saskatchewan (97th) Avenue and Curry (100th) Street

Single-track Special Work

Type	Location
Car Barn Special	Beech (117th) Avenue and Douglas (78th) Street
Combination Y and Crossover	24th (124th) Street and Tretheway (105th) Avenue
Right Hand Crossover	Alberta (118th) Avenue and Kennedy (93rd) Street
Right Hand Crossover	1st (101st) Street and Vermilion (106th) Avenue
Right Hand Crossover	Syndicate Avenue (95th Street) and Edmiston Street (110A Avenue)
Right Hand Crossover	Jasper Avenue and 9th (109th Street
Right Hand Crossover	24th (124th) Street and Nipigon (112th) Avenue
Right Hand Crossover	Saskatchewan (97th) Avenue and 8th (108th) Street
Right Hand Crossover	5th Street East (99th Street) and 10th Avenue North (92nd Avenue)
Right Hand Crossover	Whyte (82nd) Avenue and 4th Street West (108th Avenue)

from the paved street, it was necessary to install a series of sharply-curved and closely-spaced right hand branch-offs. These branch-offs were made of grooved girder guard rails (Lorain 108-398) as well as some special rail profiles. The branch-offs were fabricated to conform to specifications provided by the ERR. A total of 5 left hand and 8 right hand branch-offs comprised the "car barn special". (Lorain Steel Company blueprints, 1913)

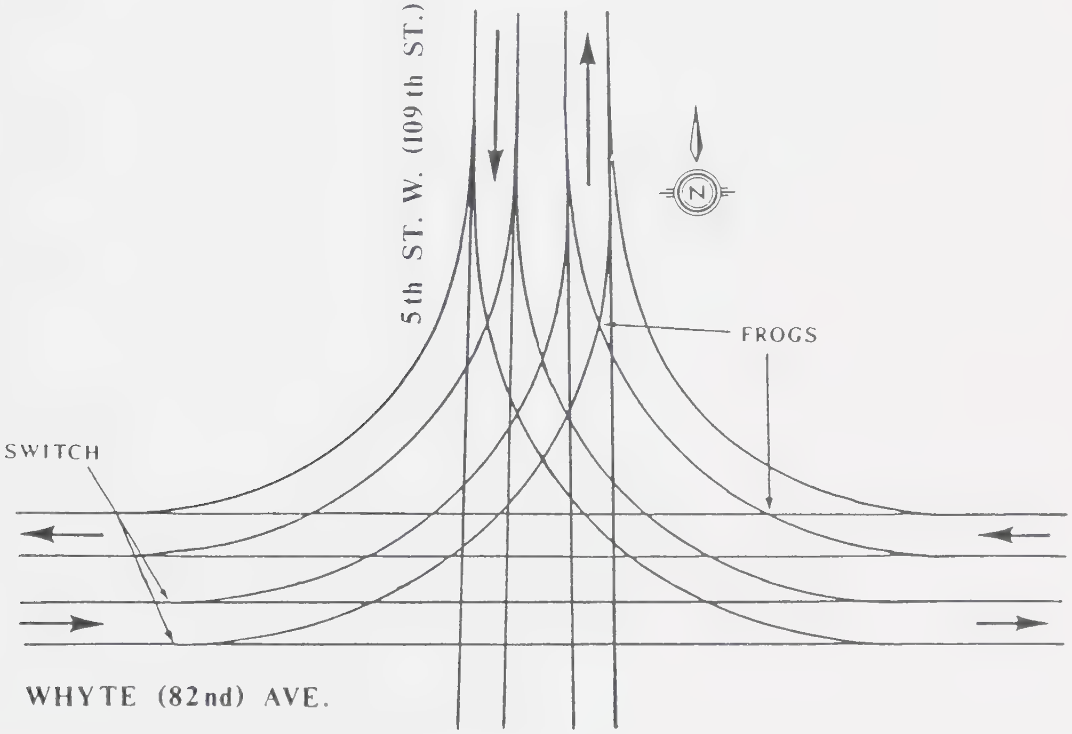


FIGURE 13. PLAN OF THREE-PART THROUGH Y

Installation of the special work was accomplished in a manner similar to that used for the installation of permanent tangent track. After the sub-grade, which conformed to the shape of the special work, had been prepared and the 6 inch (152 mm) thick concrete slab poured and hardened, crews deposited a 1 inch to 2 inch (25.4 mm to 51 mm) thick layer of sand over the entire surface. Standard size fir ties were then placed

on the sand-covered slab at intervals of 2 feet (610 mm), measured centre to centre. The ties were also placed so that they would lie beneath the special work. (CEED Drawing S.R.13 #4, February 1913, and ERR Drawings showing standard tie layouts for various pieces of special work, 1913)

The parts of the special work were laid on the ties in their correct locations, according to the numbers on the blueprint and by the numbers painted on the ends of the parts. When all parts were accounted for and were located properly, the pieces were bolted together at the ends using angle bars and track bolts. Proper track gauge was maintained by means of tie rods. Tie rods were rectangular bars of steel which were installed between the rails at varying intervals. (Hadfields Steel Foundry blueprints and Lorain Steel Company blueprints, 1912-1913) The tie rods had threaded rods formed at either end which were designed to be placed in holes drilled through the webs of the rails. Tie rods were held in place by nuts that were placed on the ends of the rods and tightened against the webs of the rails. If installed properly, the tie rods would ensure the correct track gauge throughout the entire special work. Plate 10 (Provincial Arhives of Alberta) shows crews assembling the grand union at Ninth (109th) Street and Jasper Avenue. The placement of the ties as well as the tie rods should be noted.

In the next step of the assembly, the special work was attached to the ends of the tangent rails. If the adjoining rail was the same height as the rail in the special work, standard angle bars could be used. In many instances, however, the special work had to be connected with 80 pound per yard (33.2 kg/m) ASCE T-rail which was shorter than the grooved girder guard rails used. Special angle bars known as "compromise angle bars" were used to join ASCE rail to the rails in special work.

Plate 10. (Provincial Archives of Alberta) Construction of Grand Union, 1913

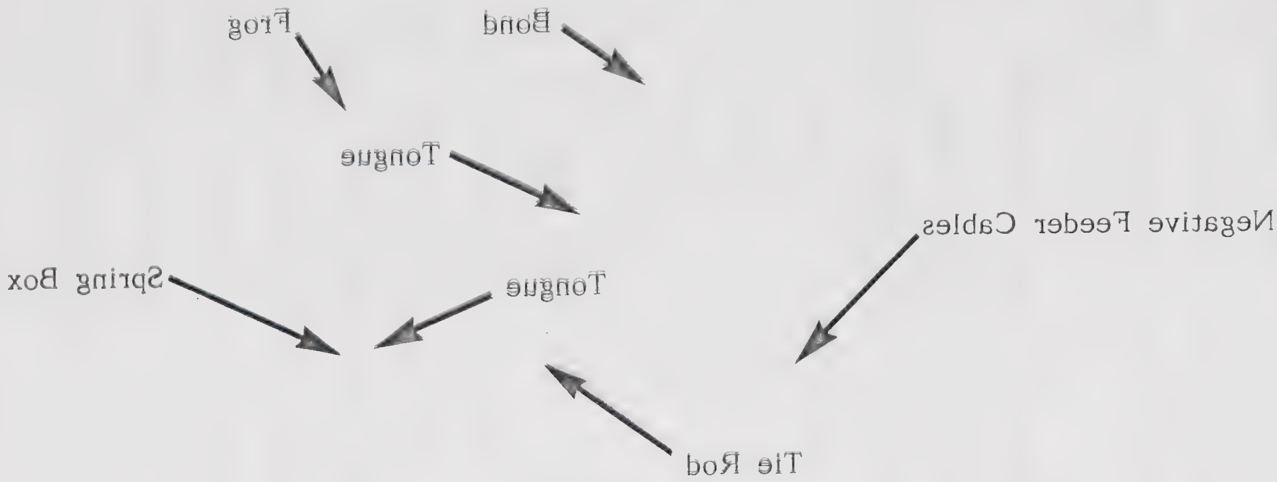

Frog
Bond
Tongue
Negative Feeder Cables
Spring Box
Tongue
Tie Rod

Plate 10. (Provincial Archives of Alberta) Construction of Grand Union, 1913

(ERR Drawing of a compromise rail joint, May 1913) A compromise angle bar was similar in basic design to a standard angle bar. The difference was that one half of the compromise angle bar fitted the grooved girder guard rail while the other half fitted the shorter ASCE T-rail. Compromise angle bars were attached to the rails by means of track bolts. When all connections were made, concrete was poured between the rails of the special work until the tops of the ties were covered.

The final step in the installation of special work was the construction of the pavement. The method used was similar to that used for tangent track. The only difference was that flangeways did not have to be formed since the lip of the grooved girder guard rail had already provided a flangeway. When the pavement had hardened, the installation was considered complete.

The locations of the permanent special work installed during 1913 can be seen on Map 8 (after Official Map of the City of Edmonton, 1938, CEAR, 1913, pp. 286-287, ERR Drawings of special work, 1913).

At this juncture, descriptions and explanations of the types of special work switches (sometimes known as points) will be given. Most standard railway switches used after 1900 were called movable switches. This type of switch, frequently used in ERR temporary construction, consisted primarily of two interconnected movable sections of tapered rail, known as tongues. (Dover, 1929, p. 537, and ERR Drawings of standard switches, 1913) In the normal running position, one tonue fitted against the inside head of one of the running rails, the other tongue rested far enough away from the rail head to allow a flanged wheel to pass unhindered. A streetcar entering a switch in this position would travel straight through. When someone "threw" the switch, usually by moving a lever arrangement called a switch stand, the position of the two tongues would

be reversed. The result would be that a streetcar entering the switch would be diverted to another track. This occurred because the tongue that was now against the rail head curved away from the direction of the through track and directed the flanged streetcar wheel through a frog and onto another track. The wheel on the other end of the axle would take the curve because the tongue that had been against the rail head now provided a curved path to the divergent track. This operating principle was applied to some switches found in street railway work. Movable switches were usually found in branch-offs, crossovers and three-part Y's. (Dover, 1929, p. 537) Although special work movable switches were similar to ordinary railroad switches, there were several differences. Where railroad switches were usually thrown by means of a switch stand, special work switches on the ERR were usually thrown by means of a switch iron. (Dover, p. 537) A switch iron consisted of a steel rod, usually about 3 feet (0.91 m) in length, that had a handle at one end and a flat vertical blade at the opposite end. To throw a switch, the motorman (operator) of the streetcar stopped before reaching the switch tongues. With most ERR streetcars, the motorman had to step onto the street in order to be able to throw the switch. When he arrived at the switch tongues, the motorman inserted the blade of the switch iron between one of the tongues and the rail heads and then pushed the tongues over to the opposite position, using the switch iron as a lever. The streetcar could then proceed. The tongues were held in position by an arrangement of strong springs and levers located in steel boxes at either side of the tongues. Examples of these spring boxes are indicated on Plate 10. Another difference between standard movable railway switches and special work movable switches was that the tongues of the special work switches were located within grooves. This was

necessary because such switches were normally located on paved streets and it was essential that the paving material not interfere with the movement of the switch tongues. In addition, most special work was made with grooved girder guard rail and in order to continue the protection of the guard feature throughout the special work, it was necessary to place the switch tongues within grooves. (Dover, pp. 534-539) There were other types of special work switches used on the ERR besides the movable tongue type.

When it was necessary for a streetcar to enter a track through a three-part Y, for example, it was first necessary for a movable switch to be thrown. When the streetcar had entered the curved section of the special work, it approached another switch and the tongues would be pointing away from the streetcar. If the switch was a basic movable tongue switch, the motorman would have to get out and walk to one of the tongues and throw the switch. To avoid this problem, a switch known as an automatic, trailing or spring switch was used. A spring switch was virtually identical to the movable switch except that the spring switch could be thrown by the passing of the streetcar wheels through the switch. Since the switch was arranged in the opposite manner to a movable switch, the flanges of the streetcar wheels would push against the switch tongues and force them over. After the streetcar had passed, springs in the switch would return the tongues to their original position. (Dover, p. 537) By using spring trailing switches, an additional stop was eliminated in the travel of the streetcar.

A third type of switch was used in complex special work such as grand unions and three-part through Y's. It was called an open switch, sometimes referred to as an open point. (Dover, p. 537) Open switches, which were used in connection with a modified form of the movable

tongue switch, did not have tongues similar to those described previously. (Dover, pp. 535-537) Upon approaching an open switch one would observe a short tongue on one track. On the adjacent track, further along, there would be a piece of track work that resembled a tongue fixed between normal positions. Immediately beyond this "fixed tongue", there would be another short movable tongue. On the opposite rail there would be a second fixed tongue a short distance along. This arrangement can be seen in Plate 10. It should be noted that the small movable tongues were not interconnected. The operation of an open switch was fairly simple. When approaching the special work the motorman would stop the streetcar and would walk to the first small movable tongue. Depending on its position, the streetcar could proceed straight or could be diverted onto the first turn. If the streetcar were supposed to travel straight through the special work, the motorman would approach the second small movable tongue and would position it so that the second turn would not be taken. Since the movable tongues were located before the fixed tongues, the streetcar's wheels would follow the path determined by the positions of the small movable tongues. With this arrangement, a streetcar could go in one of three directions. Open switches were also used on car barn special work. (Lorain Steel Company blueprints showing layout of special work at new car barns, 1913)

Temporary Construction, 1913

Although most of the track constructed in 1913 was permanent track, a total of 7.67 miles (12.34 km) of single and double temporary track, measured as single track, was built. (CEAR, 1913, p. 287) Two types of temporary construction were employed. They were known as type A and type B. Type A, which was a new form of construction,

was intended to be used on graded roads with frequent vehicular traffic. Type B, which was similar to 1908 temporary construction, was intended to be used on right of ways or on rarely used roads. (ERR Drawings of temporary track construction, 1913)

Type A construction was usually double-track. Construction began following the grading of the road. The first step in the track construction was the excavation of a straight-sided trench along the centre of the road. The trench was intended to be 15 inches (381 mm) deep and 19 feet (5 791 mm) across. Following the excavation, a layer of gravel approximately 4 inches (102 mm) thick was deposited along the bottom of the trench. Standard fir ties were then placed on top of the gravel in two rows. The ties in each row were spaced 2 feet (610 mm) apart, measured centre to centre. Each row was so placed that, when complete, the centres of the two tracks would be 10 feet (3 048 mm) apart. When the ties were placed in their proper positions, 33 foot (10 006 mm) lengths of 80 pound per yard (33.2 kg/m) ASCE T-rail were placed on the ties. The rail sections were joined using continuous angle bars. Following this, the rails were aligned and spiked to the ties. Gravel was then deposited around the rails until it came within ½ inch (12.7 mm) of the top of the rail heads. Between the running rails, however, the gravel was crowned. (ERR Drawing of Standard Temporary Double Track Type A, 1913) When the gravel was deposited and tamped into place, the construction was considered complete. Figure 14 (after ERR Drawing of Standard Temporary Double Track Type A, 1913) shows a cross-section through type A temporary double track. Although the original drawing dates from 1913, minor deletions as well as the metric conversion were made by this author.

Type B temporary track was usually single-track. The preparation

of a suitable sub-grade was the first step in construction. A graded surface approximately 14 feet (4 267 mm) across was prepared along the route of the track. The sides of the sub-grade were to slope 60° down from the graded surface. Drainage ditches were to be formed at convenient distances below the graded surface. (ERR Drawing of Standard Temporary Single Track Type B, 1913) Following the completion of the sub-grade, a 6 inch (152 mm) thick layer of gravel or broken

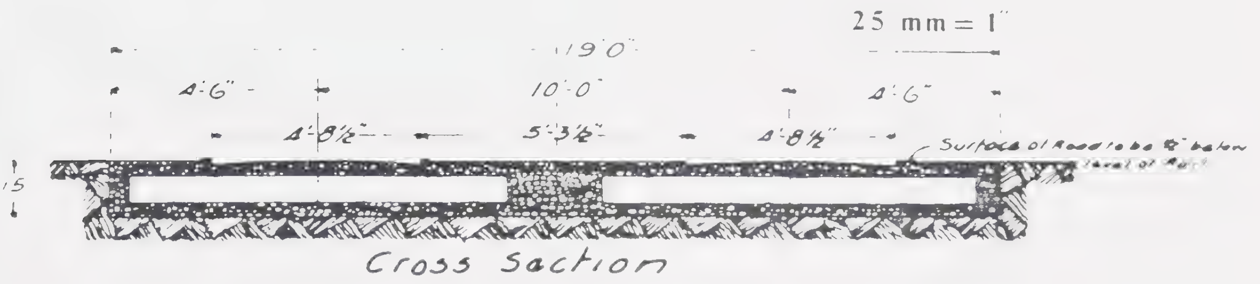


FIGURE 14. TYPE A TEMPORARY CONSTRUCTION

stone was deposited along the graded surface. Standard fir ties spaced 2 feet (610 mm) centre to centre were then laid on the gravel. In the next step, lengths of 60 pound per yard (24.9 kg/m) ASCE T-rail were placed on the ties. The rail lengths were joined by ordinary single bars. The rails were then aligned and spiked to the ties. Another layer of gravel or broken stone was deposited. However, this layer was deposited between the rails until even with the tops of the rail heads. The final step of the construction consisted of shaping the gravel or broken stone so that it sloped away from the centre of the ties, past the ends of the ties to the graded surface. (ERR Drawing of Standard Temporary Single Track Type B, 1913) The appearance of type B temporary track was similar to the 1908 type of temporary construction. The longest

distance of type B temporary construction built in 1913 was along 6th Avenue South (76th Avenue) between 2nd Street West (106th Street) and 12th Street West (116th Street). (CEAR, 1913, p. 287) This 1.246 mile (2.0 km) section of track was later known as the "McKernan's Lake Line". In 1913, and for many subsequent years, there were few buildings near the line. It was built to satisfy the requirements of the Edmonton-Strathcona Amalgamation Agreement. (CEAR, p. 287, and Statutes of Alberta, 1911-1912, Chapter 66, pp. 529-530).

Maps 8, 9 and 10 (after Official Map of the City of Edmonton, 1938, and CEAR, 1913, pp. 286-287) show the locations of all temporary track constructed during 1913.

Freight Track, 1913

The ERR, through its new interchange with the CNOR, constructed at the new Cromdale barns, was able to provide faster distribution of goods to its customers in the northern parts of Edmonton. (ERR Drawings showing layout of tracks at new car barns, 1913, and CEAR, 1912, p. 207) In addition to the interchange, two new spur tracks were constructed.

One spur was constructed south from the southern or east-bound track on Alberta (118th) Avenue between Duprau (68th) and Wadleigh (67th) Streets, into the yard of E. Bashaw and Sons, sash and door manufacturers. (North Edmonton Industrial Review, 1913) This firm later became the Graves Lumber Yard. (Henderson's City Directory, 1925) The other spur was built to serve the wholesale jobbing firm of Robarts and Boon which was located on Syndicate Avenue (95th Street) between Griesbach and Sutherland Streets (105A and 106th Avenues). (Henderson's Edmonton City Directory, 1914) The track branched off to the north-

east from the single track on Syndicate Avenue (95th Street) and proceeded in an easterly direction into the Robarts and Boon yard.

Freight track construction methods were usually constructed to the type B temporary track standard. Freight spurs were not usually ballasted, however. (See Plate 7) The location of the freight spurs constructed in 1913 can be seen on Maps 8 and 9.

Track Removal, 1913

Two temporary track stub-lines became redundant in 1913 as the result of the installation of permanent through-lines nearby. One of the stub-lines so affected was located on Vermilion (106th) Avenue. (See Maps 4 and 6) Although the line served a residential area, the revenue received was substantially less than the operating costs. (CEAR, 1910, p. 111) By 1912, a track connecting 1st (101st) Street and 24th (124th) Street was desired. Nelson (107th) Avenue was selected primarily because it provided a direct route. The Vermilion (106th) Avenue route would have had to have been diverted around the Edmonton Cemetery. (Edmonton Journal, May 1, 1912, p. 2) For these reasons, the Vermilion (106th) Avenue line was abandoned and the track removed.

The other stub track to be removed was the single-track line between Whyte (82nd) Avenue and 5th Street North (87th Avenue). The line did not have heavy ridership as the result of infrequent service. In addition, only double-end streetcars could be used since the line had no facility at its terminus for turning this type of streetcar around. The opening of the High Level Bridge provided very frequent streetcar service, both north-bound and south-bound. The distance from the High Level Bridge lines to the buildings of the University of Alberta was about the same as the distance between the end of the stub-line and the buildings. No

justification for retaining the stub-line could be found by administrative personnel. It was, therefore, removed.

With the completion of the new Cromdale streetcar barns located at Beech (117th) Avenue and John (80th) Street, the ERR's original facility located on Syndicate Avenue (95th Street) became obsolete. The building was leased to the Edmonton Public School Board as a Technical School. (CECR No. 607, April 13, 1914) The tracks to the building were no longer required and they were removed. In addition, the trackage behind the old car barns was also removed. The removal did not include the short freight spur to Rendall, MacKay and Michie installed in 1912. (SRDMR, June-December 1913)

Permanent Construction, 1914

It would appear, from the large distances of track constructed in 1913 and the reported increase in City population, that the ERR would continue to expand rapidly. (CEAR, 1913, pp. 285-289) This was not to happen, however. Towards the end of 1913, it had become apparent that ridership on the ERR had stabilized and had not risen to the levels anticipated. In addition, the ERR incurred a heavy deficit as the result of several newly constructed lines not earning adequate revenue. (CEAR, p. 15, p. 45, p. 289) In consequence of these developments, it was decided by many City officials that large track construction projects were to be avoided until the track already constructed was more fully used. (CEAR, p. 15) A total of 2.745 miles (4.42 km) of permanent double-track was constructed, however, in 1914. (SRDMR, December 1914, n.b. the report lists the total distance of double-track constructed as 4.01 miles (6.45 km) The figure included the 1.265 mile (2.04 km) section of track on Portage (Kingsway) Avenue that was not completed until

1916. It should be noted that most of this construction replaced single and double temporary track laid in previous years. It appears, therefore, that former Superintendent Knight's policy of replacing temporary track with permanent track was still being followed. The largest portion replaced was along Nelson and Short (107th) Avenue between 11½ Street (no longer extant; between 111th and 112th Streets) and 24th (124th) Street. (SRDGL, Account C4A) One double-track extension was started in 1914 along Portage (Kingsway) Avenue. This extension was begun as the result of an agreement between the City and the Hudson's Bay Company which owned the land where Portage (Kingsway) Avenue lay. In essence, the Hudson's Bay Company agreed to underwrite the costs of paving Portage Avenue if the City would construct a double-track streetcar line along the road. One third of the construction was to take place in 1914. Tracks were laid along Portage Avenue between 1st (101st) Street and Norwood Boulevard (111th Avenue). (Edmonton Official Gazette, April 2, 1914, p. 45) It should be noted that special work was not installed at 1st (101st) Street so the tracks on Portage Avenue were not connected to the ERR. Map 8 (after Official Map of the City of Edmonton, 1938, CEAR, 1913, pp. 285-287, and Edmonton Official Gazette, April 2, 1914, p. 45) shows the locations of the permanent track constructed in 1914.

Although the concrete slab type of construction was used in 1914, several modifications were introduced that distinguished it from the type used in 1913. The construction procedure was unaltered until after the crews deposited the layer of sand on the hardened concrete slab. Following the deposition of the sand layer, crews placed a layer of expanded metal mesh over the sand. The mesh was intended to reinforce the next layer of concrete deposited. (CEED Drawing of 1914 Street Railway

Construction) The ties were then placed on the metal mesh at 2 foot (610 mm) intervals. Rails were then placed, connected, aligned and spiked to the ties by the same methods that were used in 1913. The preparation of the paved surface was the final step in the construction. Concrete was first deposited around the ties until the bases of the rails were covered. When the concrete had hardened, shaped sandstone blocks were fitted against facing webs of the rails in order to provide flangeways. The blocks were held in place with a mortar mixture. (CEED Sketch Showing Detail of Sandstone Set, 1914) A third layer of concrete was then deposited between the rails and around the sandstone blocks as well as outside the rails to the sides of the trench. This layer of concrete was intended to be even with the bottoms of the rail heads. The final surface, which came within ¼ inch (6.4 mm) of the tops of the rails consisted of an asphaltic or bituminous compound. The asphaltic surface, which was even with the tops of the sandstone blocks and even with the sides of the trench, was crowned to provide drainage of the trackage area. (CEED Drawing of Cross Sections of Double Tracks, 1914) Construction was considered finished following the completion of the asphaltic surface.

Permanent Construction, 1915

It was mentioned in the previous section that stable ridership and high deficits were the major reasons for the curtailment of large construction projects. In addition, the start of the First World War in August 1914 contributed to a further drop in ERR ridership as well as to a drop in Edmonton's population. (Yorath, 1924, p. 45) In consequence of these factors, a very small amount of construction was undertaken during 1915. Most of the construction consisted of the building of another portion

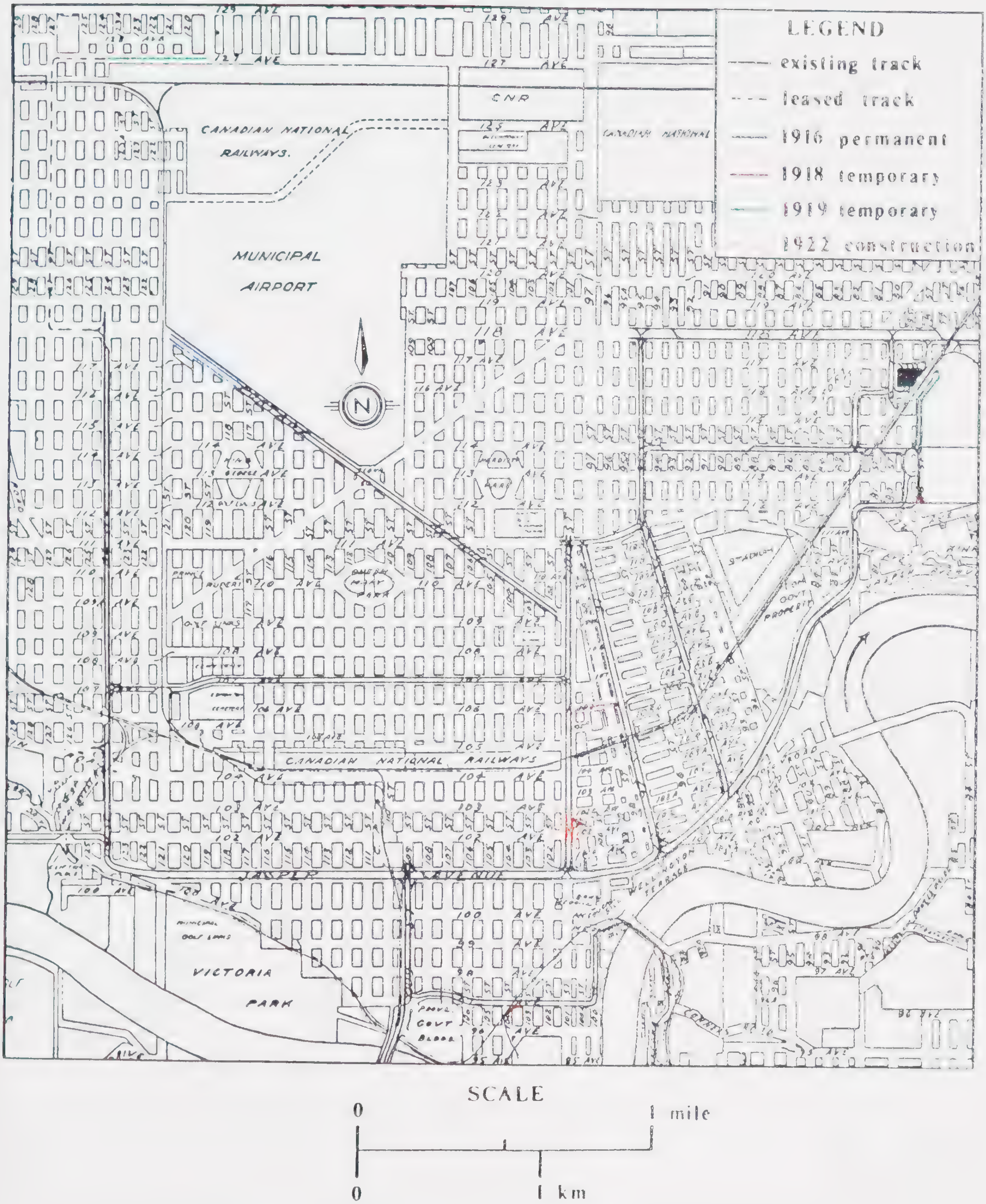
of the double-track line on Portage (Kingsway) Avenue. Tracks were laid from Norwood Boulevard (111th Avenue) to Oak (116th) Avenue. (Canadian Railway and Marine World, November 1915, p. 441) The concrete slab type of construction was employed again. The 1915 style of construction reverted to the methods used during 1913. The sandstone blocks and the wire mesh used in the 1914 construction method were dispensed with. Unlike the 1913 construction, however, the final layer of concrete was not reinforced with wire mesh, and the surface was not scored to resemble bricks. The reduction of construction costs appears to have been the major reason why the 1914 method of construction was abandoned. (CECR No. 38, February 16, 1915) In a manner similar to that used in 1913, the flangeways were formed with templates before the concrete hardened. (CEED, Drawings of 1915 Street Railway Track Construction) The only other construction to take place during 1915 was the installation of two pieces of special work near the High Level Bridge. (CECR No. 38, February 16, 1915)

It had been mentioned, in a previous section that described 1913 permanent construction, that the approach tracks to the High Level Bridge allowed streetcars to traverse the bridge on tracks that were on either side of the central CPR track. It was also mentioned that single-end cars had a safety problem with this arrangement, their doors opened directly onto a long drop to the river. In order to eliminate this problem, the ERR and the City Engineers decided to install crossings at both ends of the bridge so that north-bound streetcars would use the western track where they had formerly used the eastern track. Conversely, south-bound streetcars would use the eastern track where they had previously used the western track. With the crossings, the doors of single-end streetcars now faced the CPR track, a preferable means of escape in case of

emergency, to the long drop to the river. After a streetcar had crossed the bridge, it would pass through the other crossing, thereby returning to the proper side of the street. The two crossings were built by the Lorain Steel Company in 1914. They consisted of 80 pounds per yard (33.2 kg/m) ASCE T-rails and 4 frogs each. (Lorain Steel Company blueprints of Crossings for High Level Bridge, 1914) The crossings were installed during 1915. (CECR No. 38, February 16, 1915) In order to install the crossings, some of the existing permanent track had to be removed or re-aligned. Figure 15 (after CEED Drawing of North Approach to the High Level Bridge, 1915) shows the plan view of the crossing installed at the north end of the High Level Bridge. The location of the old approaches to the bridge should be noted. The location of 1915 construction can be seen on Map 8.

Permanent Construction, 1916

A further drop in ridership during 1915 discouraged the ERR from considering the construction of substantial extensions to the permanent track. (Yorath, 1924, p. 45) In consequence, the only new permanent track constructed was the final portion of the double-track line on Portage (Kingsway) Avenue between Oak (116th) Avenue and 21st (121st) Street. (Edmonton Journal, October 9, 1916, p. 3) See Map 11 for location. The use of the concrete slab type of construction was continued but some changes in the method of pavement construction were introduced. After the sub-base, base, ties and rails had been prepared in accordance with the methods described for 1913, crews applied a coating of mastic, a resin-based water proofing compound, to both sides of each rail. In addition, a treated wooden filler strip was installed between the bottom of the rail head and the top of the rail foot on the sides of the rails



MAP 11. EXTENT & TYPE OF CONSTRUCTION 1916 – 1922

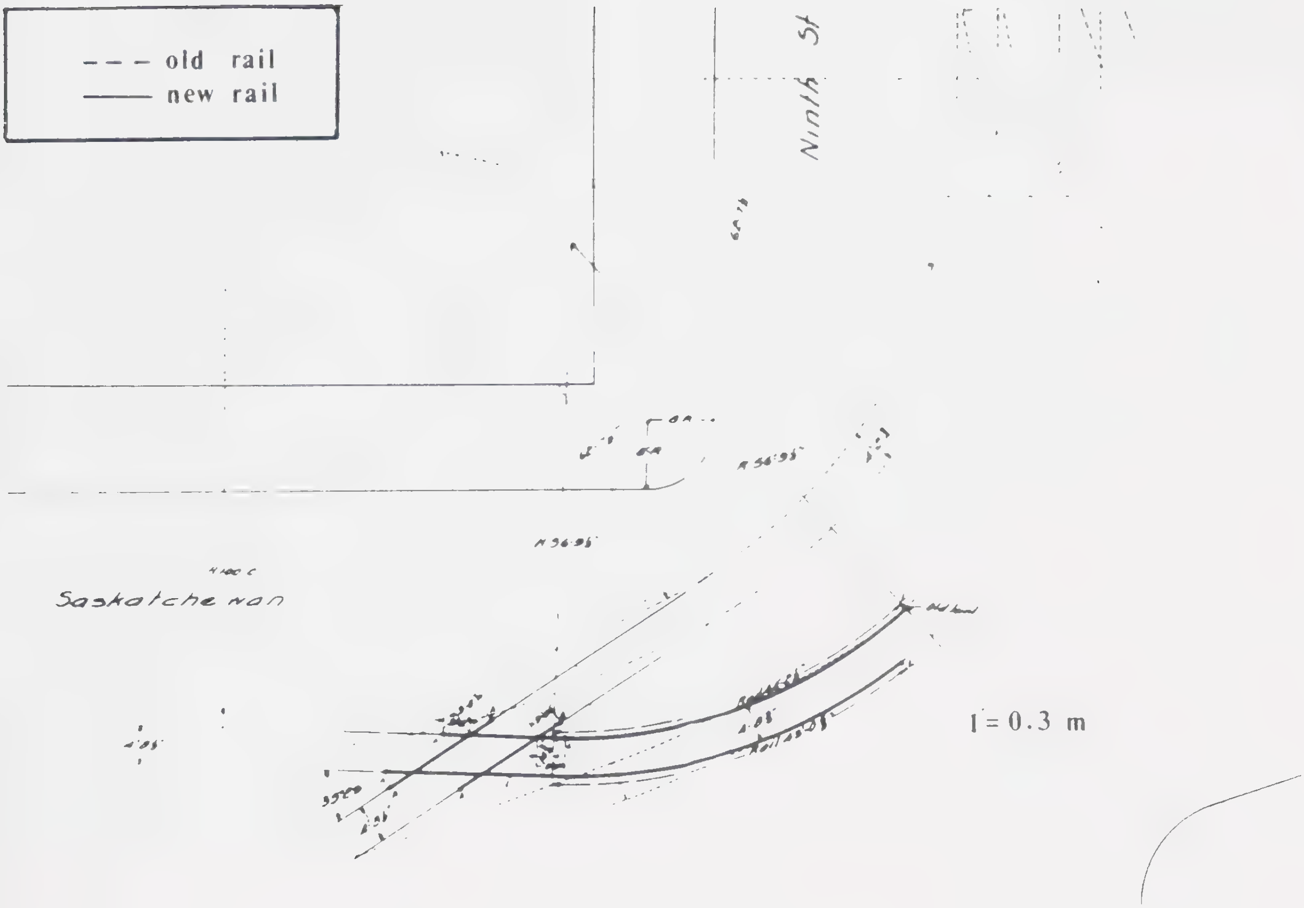


FIGURE 15. NORTHERN CROSSING NEAR HIGH LEVEL BRIDGE

that faced the sides of the trench. (CEED Cross-sectional drawing of 1916 track construction) The purpose of the filler strip was to provide a relatively flat surface on that particular side of the rail in order to facilitate a subsequent step of the construction. When the filler strip had been installed and secured with mastic, a thin layer of concrete was deposited on top of the ties between the ends of the ties and the rails. The concrete sloped away from the rails towards the edges of the trench. When the concrete had hardened, the surface was coated

with a layer of mastic. Two rows of 3½ inch square (89 mm^2) wooden blocks were placed next to the sides of the rails with the filler strips. The two rows of blocks were separated by a layer of mastic. (CEED, Cross-sectional drawing of 1916 track construction) The purpose of the blocks was to impart some lateral flexibility to the pavement. As a result of extreme temperature fluctuations in Edmonton, the resiliency of the blocks was thought to reduce the problem of the pavement cracking next to the rails. Following the installation of the blocks, a 4 inch (102 mm) layer of concrete was deposited between the rails. When levelled, this layer of concrete was ½ inch (13 mm) below the top of the rail heads. Before the concrete hardened, flangeways were formed with templates. In addition, 2½ inch (63.5 mm) deep expansion joints were formed in the concrete 7 inches (178 mm) from the rail heads, running parallel with the rails. (CEED Cross-sectional drawing of 1916 track construction) In the area between the sides of the trench and the tracks, a layer of concrete was deposited that covered, approximately, half the height of the wood blocks. When the concrete had hardened, asphalt was deposited on top until it was even with the tops of the wood blocks and even with the sides of the trench. Figure 16 (after CEED Cross-sectional drawing of 1916 track construction) shows the appearance, in cross-section, of the permanent construction just described. Although the original drawing has been presented, minor deletions and additions were done by this author.

Leased Trackage, 1916-1921

In December 1913, a private railway known as the Edmonton Inter-urban Railway (EIR) connected its line running from the Town of St. Albert to the terminus of the ERR track on 24th (124th) Street and

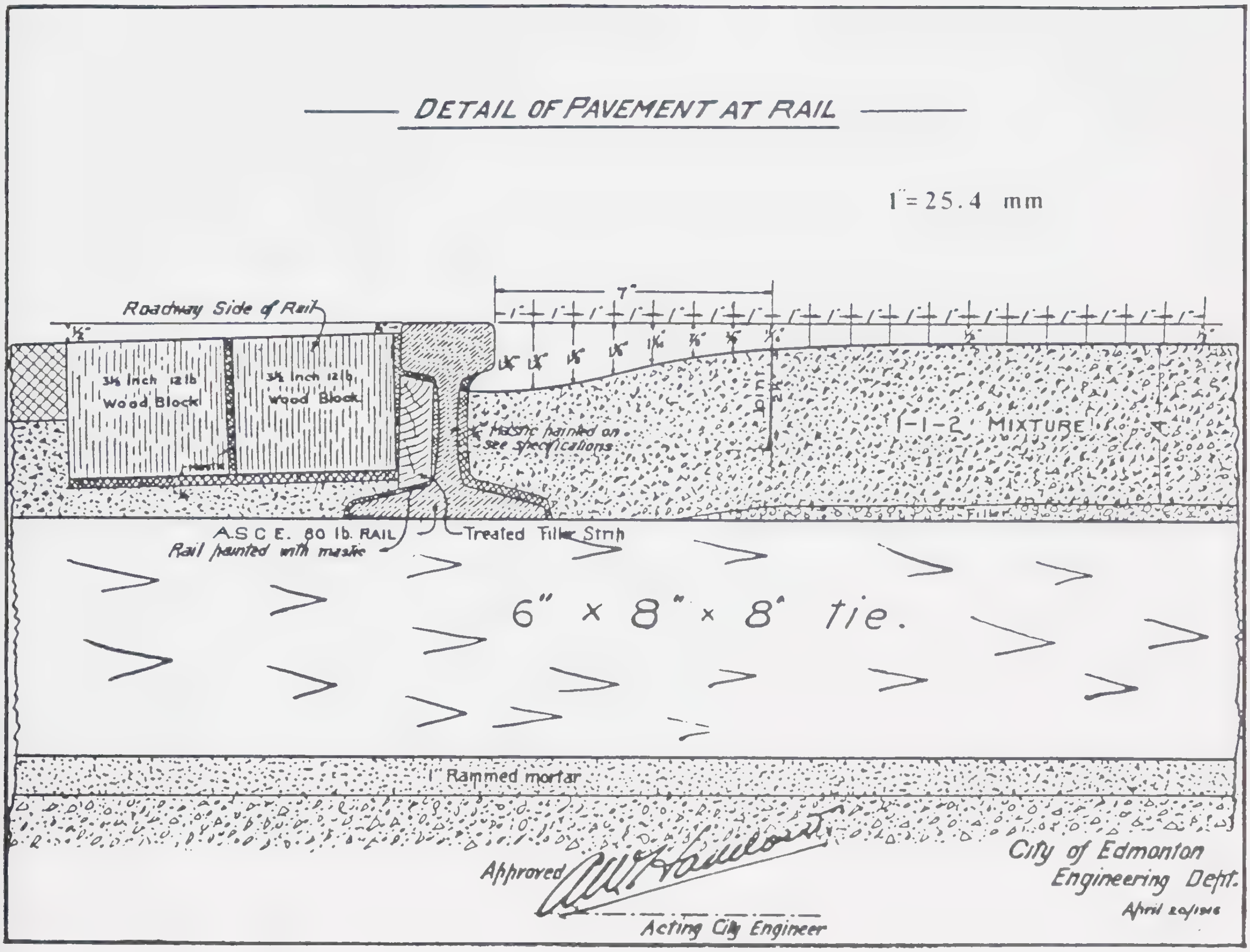


FIGURE 16. CROSS-SECTION OF 1916 PERMANENT CONSTRUCTION

Alberta (118th) Avenue. The EIR's revenue-earning rolling stock consisted of one self-propelled interurban streetcar which was moved by electric motors. The motors received their power from an on-board generator which was powered by a gasoline engine. (Canadian Railway and Marine World, March 1914, p. 135) It was, therefore, easy for the EIR's interurban streetcar to travel along ERR trackage. It was not possible, though, for ERR streetcars to use the EIR track since there was no electrical distribution system on EIR lines. When the EIR's interurban streetcar

burned in 1914, their line could not be used. Many residents of both Edmonton and the Town of Calder, which was located immediately north of Edmonton, urged the City to provide streetcar service to Calder. The ERR and the City did not have the financial resources necessary to construct an extension to Calder. The City, therefore, negotiated with the directors of the EIR with the intent of leasing a portion of that railway's trackage. An agreement between the City and the EIR was concluded in September 1915. (Canadian Railway and Marine World, October 1915, p. 404) The length of the EIR track leased was 1.13 miles (1.8 km), all of it built to a standard that resembled ERR temporary track constructed before 1913. (Canadian Railway and Marine World, February 1917, p. 71) Before the ERR could operate the leased section, two important actions had to occur. Overhead wire for electrical distribution had to be installed. This work was done early in 1916. (Canadian Railway and Marine World, February 1916, p. 73) In addition, the ERR had to obtain permission from the BRC in order to reinstall the crossing with the GTP on 27th (127th) Street between Armstrong (126th) and Cochrane (126A) Avenues. The BRC gave its approval to the ERR for the installation of this crossing in August 1916, with the proviso that the ERR install a half interlocking plant to protect the crossing. (Canadian Railway and Marine World, September 1916, p. 378)

A half interlocking plant consisted of two derails installed on one of the intersecting tracks, the derails being placed on either side of the crossing. Derails were metal devices that could be placed on top of a rail. They were designed to prevent any vehicle using the track from proceeding unless authorized to do so. The derails accomplished this by causing one set of wheels to lift from the rail head and to travel off the track. The derails, which were located several yards (metres)

before the crossing, were interlocked with two sets of signals, one set for each intersecting line. The signals on the line with the derails would normally be set in the stop position, while the signals for the other line would normally be set in the proceed position. (Harding & Ewing, 1926, pp. 240-256) The entire installation was referred to as a half interlocking plant. (CNR Drawing of half interlocking plant on 107th Avenue, 1923) The signals were usually of the semaphore type (i.e. they had a movable board or "arm" as well as colored lights to indicate stop or proceed) but many were replaced several years later by signals that displayed colored lights only. A full interlocking plant, which was usually installed at the intersection of two heavily-used steam railroad lines, consisted of derails and signals installed on both intersecting lines. (Harding & Ewing, 1926, pp. 240-256)

The ERR track had the derails installed. With the half interlocking plant, GTP trains could, usually, proceed unimpeded through the crossing. For ERR streetcars to cross the GTP track, however, a watchman had to move the derail away from the top of the rail after he had determined that no train was approaching. The watchman, by means of levers, would then move the ERR signal to the proceed position and would also move the GTP signals to the stop position. The streetcar could then proceed through the crossing. Once the streetcar had passed through the crossing, the derail and the signals would be returned to their normal positions. A similar half interlocking plant had been installed on the ERR track on Nelson (107th) Avenue in 1914. (Edmonton Official Gazette, April 2, 1914, p. 45, and information located on CNR drawing of half interlocking plant on 107th Avenue, 1923) The purpose of an interlocking plant was to prevent accidents between trains and streetcars, although accidents did sometimes occur in spite of the protection. All the crossings between

the ERR and steam railroads were not protected by interlocking devices. It was the prerogative of the BRC to decide whether a crossing needed protection or not. Unless the steam railroad had a heavy traffic flow, and could prove this to the satisfaction of the BRC, the BRC would not order the ERR to install protection. It is for this reason that most of the ERR crossings with steam railroads, including the crossings at either end of the Low Level Bridge, were not protected. (BRC Orders, Numbers: 5608, November 3, 1908; 5598, November 12, 1908; 5691, November 24, 1908; 6410, February 19, 1909; 6751, February 19, 1909)

Following the installation of the half interlocking plant, the ERR placed the leased portion of the EIR track in service. The track was leased from the Directors of the EIR until the end of 1921, at which time it was purchased outright by the City of Edmonton. (SRDGL, Account F19) The location and extent of the track leased from the EIR may be seen on Map 11.

Reconstruction, 1916

It had been believed by many City officials that the concrete slab method of permanent construction introduced in 1913 was superior to the construction methods that had been used previously because it was thought that the 1913 permanent construction would last for "at least fifteen years" (CEAR, 1913, p. 286) Towards the end of 1915, however, one particular section of double-track had deteriorated to such an extent that some streetcars were derailing. The track was located on Alberta (118th) Avenue between Kirkness (95th) and Douglas (78th) Streets. (CEAR, p. 285) See Map 8 for the location. The problem with the track was that it was bending down at the rail joints. This caused the streetcars to bounce as they travelled along the track. (CECR No. 248, November

29, 1915) It should be remembered that continuous angle bars were used in the construction. No provision for tie placement near the joints was specified, however. As a result of ambiguous plans, the crews who constructed that section of double-track did not place the ties near the rail joints. The stress on the unsupported joints was sufficient to bend the rails at those points. In addition, since tie plates were not used, the rails tended to crush the ties and also tended to pulverise the surrounding concrete fill. The track eventually became so loose and undulating that major repairs were required in order to prevent serious and frequent derailments. (CECR No. 248) The blame for sub-standard construction of this track was directed towards the former Superintendent, W. T. Woodroofe, who had insisted on not using tie plates. Woodroofe was unable to answer the charges because he had resigned from the ERR in April 1914 and was no longer in Edmonton. (Canadian Railway and Marine World, April 1914, p. 185) In fairness to Woodroofe, some of the blame should have been directed to other ERR personnel as well as to the City Engineer who were responsible for the faulty tie placement. In any event, the ERR reconstructed the double-track on Alberta (118th) Avenue during 1916. The deterioration of the double-track on Alberta Avenue prompted some City officials to wonder whether the 1913 permanent construction actually would last the estimated fifteen years. (CECR No. 248, November 29, 1915)

In addition to the reconstruction of the double-track on Alberta (118th) Avenue, several pieces of special work were replaced. The special work that was replaced consisted of 9 crossings (sometimes called "diamonds") with railroads, portions of the three-part Y at the intersection of 97th Street and Jasper Avenue, and the three-part Y at the intersection of 1st (101st) Street and Jasper Avenue. (CECR Nos.: 253, November

29, 1915; 121, June 5, 1916; 165, July 25, 1916) After reading the previous paragraph, one might speculate that the special work required replacement because of poor installation, or because of poor maintenance. Neither poor installation nor poor maintenance were reasons why the special work was in need of replacement. It has been mentioned in previous sections that most special work was made with hard-wearing steel alloys, primarily manganese steel. It should be noted, however, that most of the special work in need of replacement had been in service since 1908, and the frequent numbers of streetcars using the special work wore out the switch tongues, curved grooved girder guard rails, and the frogs. Maintenance of special work had been, and continued to be, a prime concern of the ERR.

As early as 1911, the ERR had employed a number of men who, in the summer months, were required to walk along sections of the track with pails of grease and short wooden sticks. These men, known as "track greasers", were supposed to apply grease to the sides of the rail heads on curves, using the sticks as applicators. In addition, they were also supposed to apply grease to any pieces of special work in their territory. (SRDMR, October 1912, and Canadian Railway and Marine World, October 1915, p. 400) The grease was intended to reduce the friction between the wheels, curved sections of rail and special work. It was also thought that the grease would reduce the noise of the streetcar wheels as they negotiated curves. It was a common complaint that streetcar wheels frequently squealed when passing through tight curves. In winter, however, the track greasers could not apply the grease because of low temperatures and snow. During the winter months, therefore, the track greasers endeavoured to keep the special work clear of snow and ice with the aid of brooms, shovels and picks. (SRDMR, October-

December, 1912) Although the track greasers serviced the special work daily, the grease could not prevent the continual pounding of the streetcar wheels over the special work. After several years, the various parts of the special work either wore out or were pounded out of shape. New special work was then required.

All of the replacement special work was ordered through the Smiley Company. This was a local jobbing firm that carried the products of the Lorain Steel Company of the United States, and the products of Edgar Allen and Company of England. (CECR Nos.: 253, November 29, 1915; 121, June 5, 1916; 165, July 25, 1916) The three-part Y's were supplied by the Lorain Steel Company and the crossings were fabricated by Edgar Allen and Company. (Lorain Steel Company blueprints of materials supplied for the three-part Y's at 1st and 97th Streets, 1916, and Edgar Allen & Co. blueprint of crossing diamond, 1916) One may wonder if there were any Canadian manufacturers of special work and, if there were, why the ERR was purchasing special work from foreign countries. Although there were several Canadian manufacturers of special work, only one chose to submit a bid for Edmonton's 1916 special work requirements. (CECR No. 165, July 25, 1916) The bid was tendered by the jobbing firm of Gorman, Clancey and Grindley on behalf of the Canadian Ramapo Iron Works of Niagara Falls, Ontario. The cost of their special work was more than $300.00 higher than the price quoted by Lorain and Edgar Allen to fabricate the special work. (CECR No. 165, July 25, 1916) In addition, the Smiley Company guaranteed delivery of the special work before the beginning of October, while Gorman, Clancey and Grindley guaranteed delivery by December. In order for the ERR to replace the special work during 1916, it was necessary to have the special work available before the beginning of October. The higher cost

combined with late delivery precluded the bid of the Canadian Ramapo Iron Works. The special work was ordered, therefore, from the Lorain Steel Company and Edgar Allen and Company, through the Smiley Company. (CECR No. 165, July 25, 1916)

Reconstruction, 1917

Towards the end of 1916, it was becoming apparent that heavy maintenance was required on some sections of permanent and temporary track constructed before 1913 if these sections were to remain in use. (CECR No. 43, February 13, 1917) Most of the permanent track that required repair consisted of lines constructed between 1907 and 1910. Part of the initial construction along Jasper Avenue, between 104th and 108 Streets, was in need of new pavement. It should be remembered that the original wood block pavement of 1907-1908 had been replaced by concrete and bitulithic pavement in 1910. After six years of heavy use, the bitulithic pavement was worn and in need of replacement. In addition, the bitulithic pavement along 101st Street as well as the paving bricks along 97th Street (formerly Namayo Avenue) were also in need of replacement. The wooden ties along 97th Street, between Jasper Avenue and the railroad tracks, had to be replaced because the spaces between the paving bricks had allowed water to accumulate around the ties, speeding their decay. (CECR No. 43, February 17, 1917) The first step required in the pavement reconstruction was the breaking up and the removal of the old pavement. When this had been done, track crews could effect any necessary repairs to the ties and to the rails. When all track repairs were complete, concrete was poured between the rails until the level was to a point $\frac{1}{4}$ inch (12.7 mm) below the tops of the rail heads. Before it hardened, the surface of the concrete was shaped

with templates so that flangeways were formed next to the rails. When the concrete had hardened, the reconstruction was considered complete.

Some sections of permanent track did not require new pavement but did require track work. Portions of track along 95th Street (formerly Kirkness Street), 118th (formerly Alberta) Avenue, and 82nd (also known as Whyte) Avenue required new rail joints. The standard angle bars used in the construction of these sections were becoming loose and were bending and breaking. The Superintendent of the ERR, J. H. Moir, recommended that the old angle bars be replaced with the continuous type of angle bar that was introduced in 1913. (CECR, May 7, 1917) To replace the angle bars, however, the pavement between the rails had to be removed and later replaced when the repair work was finished. In addition to the work already mentioned, several crossing diamonds were also replaced during 1917. (CECR No. 43, February 17, 1917)

Temporary track had also suffered from the effects of environment and time. Major repairs were required on the Highlands passenger line along 112th (formerly Knox) Avenue, between the East End (Borden) Park and 63rd (formerly Irwin) Street. Although the line was only five years old, many ties had rotted because of improper roadbed drainage and infrequent maintenance. In an attempt to prevent the line from becoming unserviceable, the ERR replaced most of the ties between the park and 63rd Street. (CECR No. 43, February 13, 1917)

Track Removal, 1917

The reconstruction of the temporary track on 112th Avenue provided the ERR with an opportunity to remove the spur on 62nd (formerly Grace) Street and the switch connecting it with 112th Avenue that had been constructed in 1912. (See Map 7 for location) It should be remembered

that the spur had been built for the sole purpose of conveying building materials to the site of the Highlands School. The spur, therefore, had not been used since the completion of the building. The management of the ERR felt that the rails and ties of the spur could be removed and used in other locations since it seemed unlikely that anyone along that spur would require freight service in future. (Edmonton Journal, November 14, 1917, p. 2)

Track crews also removed the spur that ran from 95th Street (formerly Syndicate Avenue) along 109A Avenue (formerly Gallagher Street and north to 110th Avenue (formerly Wilson Street). This spur, which had been constructed to serve the needs of a sash and door manufacturer, no longer served any businesses and was, therefore, no longer required. (SRDGL, Account F16F) In addition, crews removed the spur on 118th (formerly Alberta) Avenue that had previously served the C. F. Taylor lumber yard. (SRDGL, Account C40)

Temporary Construction, 1918

In late 1917, it had been decided by the City Commissioners and by Superintendent Moir that a single-track should be constructed along 106th Avenue (formerly Sutherland Street) to connect the tracks on 101st Street with the tracks on 97th Street. This linkage was necessary to facilitate the new belt-line route system that had been introduced in October 1917. (CECR No. 205, November 27, and Canadian Railway and Marine World, November 1917, p. 446) In previous years, the ERR constructed lines according to the radial system of routing. In the radial system, tracks were constructed from a central point towards outlying areas. Streetcars would travel back and forth along these lines. The radial system is analogous to a spoked wheel. The hub would be equi-

valent to a central point, and the spokes would be equivalent to individual tracks radiating out in all directions from the central point, hence the name Edmonton Radial Railway. In the belt-line system of routing, streetcars still travelled to and from a central point. The distinguishing feature of the belt-line system was that the streetcars used tracks on one street to travel away from the central point, and used tracks on another street to return. (Harding & Ewing, 1926, pp. 257-270)

Construction of the single-track on 106th Avenue was started in April and was completed by the end of May. (SRDGL, Account C4PP, and SRDMR, April & May 1918) The track, which was 1,135 feet (346 m) long, connected the eastern track on 101st Street to the western track on 97th Street. (SRDMR, May 1918, and ERR drawing of track system, April 1920) With this arrangement, a streetcar travelling north on 101st Street could turn east onto 106th Avenue and then turn south on 97th Street, thus reversing its direction of travel. In addition to the 106th Avenue track, a Y was installed at the intersection of 112th (formerly Pine) Avenue and 78th (formerly Park) Street. (SRDGL, Account C4) The construction method used for 1918 temporary track was the type A construction introduced in 1913.

The location of the 1918 temporary construction may be seen on Map 11.

Temporary Construction, 1919-1920

In 1919, the ridership on the ERR increased for the first time since 1912. (Yorath, 1924, p. 45) The City Commissioners and Superintendent Moir planned two new extensions that were designed to further increase ridership. One extension was to be along 127th (formerly Brandon) Avenue. (Canadian Railway and Marine World, November 1919, p. 612) It should

be remembered that the existing track on 127th Avenue was being leased from the EIR. The other extension planned was a double-track line along 78th (formerly Park) Street into the exhibition grounds. (Canadian Railway and Marine World, January 1920, p. 34) Construction was begun in October but neither extension was finished before the onset of excessive cold and snow in November. Superintendent Moir was asked to resign by the Mayor. This was done because the Mayor felt that the City was losing money not being able to transport people to and from the hockey games held at the exhibition grounds. The Mayor believed that it was because of Moir's inefficiency, not climatic conditions, that the extension to the exhibition grounds was not finished. (Edmonton Journal, January 5, 1920, p. 1) Moir eventually resigned, yet the extension could not be completed until spring. (Edmonton Journal, January 10, 1920, p. 6) The extension was 3,010 feet (917 m) long and consisted of a double-track line with a loop at its terminus in the exhibition grounds. The single-track extension along 127th Avenue went from 124th Street to 119th Street, a distance of 2,006 feet (611 m). (SRDMR, April 1920, and Canadian Railway and Marine World, January 1921, p. 36) This extension was designed to provide better service to the residents of Calder and to the workers at the GTP roundhouse. (Canadian Railway and Marine World, November 1919, p. 612) Both extensions were built using the type A method introduced in 1913.

The location of the temporary track extensions completed in 1920 may be seen on Map 11.

Track Removal and Repair, 1921

It has been mentioned in previous sections that some portions of track were rebuilt during the First World War in order to keep the lines

in serviceable condition. Some track, however, was not rebuilt because of a lack of funds and low ridership on those lines. While some sections of track were in satisfactory shape, other sections required extensive rebuilding or the use of lighter streetcars. (Canadian Railway and Marine World, November 1921, p. 605) One section in particularly poor shape was the single temporary track along 76th Avenue (the McKernan's Lake line). Large single-end streetcars were frequently used on this line. Adequate ballasting, tie replacement and maintenance had not occurred since the line had been built. The result of this neglect was frequent derailments along the line. (SRDMR, January 1920 - October 1921) The McKernan's Lake line perpetually lost revenue and both the City Commissioners and the ERR management were reluctant to spend much money to improve the track. In an attempt to preclude expensive reconstruction, the ERR: replaced some of the older ties; removed the Y at the end of the line so that only lighter-weight double-end cars could use the track; and reduced the frequency of service on the line. (SRDAR, 1921, and Canadian Railway and Marine World, November 1921, p. 605) The trackwork was completed before the end of September, at which time streetcar service along the line was reduced to one car every half hour. (Current Flashes, October 1, 1921, pp. 4-5) The reduction in service, changes in routing and the use of double-end streetcars on certain routes, enabled the ERR to remove the Y at 95th Street and 106th Avenue which was in dire need of extensive repairs. (SRDAR, 1921)

The ERR also removed all the temporary single-track along 82nd Avenue west of 109th Street. This was done because the ERR had decided to close its south-side car barns in May 1921 in an attempt to reduce operating and maintenance costs. (CECR, December 1920) In addition, the freight spur that had been built to serve the Alsip Brick and Supply

Company was removed at this time. (SRDGL, Account C4Q)

Permanent Construction, 1922

New operating routes were planned by the ERR in 1921. One change was to have some routes originate and terminate near the intersection of 101st Street and Jasper Avenue. (Current Flashes, March 15, 1922, pp. 3-4) Without the aid of a crossover or a Y, it was impossible for streetcars to turn or to reverse direction on the double-track near 101st Street and Jasper Avenue. Since single-end streetcars were prevalent on the ERR, a unit of special work known as a combination Y and crossover had to be installed. It should be remembered that such a piece of special work had been installed on 124th (formerly 24th) Street at 105th (formerly Tretheway) Avenue in 1913. (CEAR, 1913, p. 287) The appearance of this combination Y and crossover may be seen on Map 8. The new special work was installed on 101st Street. The special work required a road or a lane for the "leg" of the Y. A lane located on the east side of 101st Street, north of 102nd Avenue, was selected as a suitable location for the leg of the Y. (Letter from the City Engineer to the City Commissioners, August 11, 1927) The lane was chosen because placing the Y on a heavily travelled street would create a hazard to motorists since the streetcars usually backed into the Y. The installation of the combination Y and crossover was not a simple operation. The pavement on 101st Street had to be broken and removed. A suitable concrete base for the special work was then constructed. When the base was complete, sections of the original track were cut and removed, then the special work could be installed and connected. The paving of the special work was the final step in the installation. The location of the combination Y and crossover installed on 101st Street maybe seen

on Map 11.

Temporary Construction and Repair, 1922

A previous section mentioned that various portions of temporary track were not ballasted as often as required. One reason for this was that gravel was expensive and the ERR's deficit had been growing rapidly since 1916. (Yorath, 1924, p. 45) Something had to be done, however, to prevent the temporary track from becoming too dangerous to use. A possible alternative to gravel was found at the City Power Plant. The boilers at the power plant were heated by the burning of coal. The resulting ash and cinders had usually been discarded. The management of the ERR thought that since coal cinders were porous, hard, plentiful and inexpensive to obtain, they would make a suitable substitute for gravel ballast. The problem facing the ERR was how to get the cinders from the power plant, which was located on Ross Flats near the 105th Street Bridge (now Walterdale Bridge), to their lines. (Canadian Railway and Marine World, March 1922, p. 150)

Raw coal was shipped to the Power Plant by the EY&PR. This railroad crossed the ERR tracks on 97th (formerly Saskatchewan) Avenue, at 104th Street. (See Maps 8 and 11) The crossing was close to the City Power Plant. Permission was requested and received from the BRC, allowing the ERR to construct two switches and a short track that would connect the ERR to the EY&PR's power plant spur. (Canadian Railway and Marine World, March 1922, p. 150) The temporary track connection (interchange) enabled the EY&PR to push hopper cars loaded with ash and cinders onto the southern ERR track where they would be moved by ERR equipment. Conversely, when the hopper cars were empty, the ERR could return them to the EY&PR through the interchange. It should

be noted that the BRC did not give the ERR permission to travel on the EY&PR tracks nor did the BRC allow the EY&PR to use ERR trackage. (Canadian Railway and Marine World, March 1922, p. 150) With the new interchange, the ERR could receive adequate supplies of ballast for the maintenance of their temporary track. The movement of freight on the ERR was still important.

Temporary Track Repair and Maintenance, 1922-1951

It was mentioned in the previous section that the ERR had not kept much of its temporary track in good repair because of high costs in obtaining gravel ballast. The construction of the interchange with the EY&PR in 1922, however, provided the ERR with a means by which to obtain an ample supply of coal cinders and ash. Cinders were an inexpensive substitute for gravel. Gravel ballast was, however, occasionally used. The repair of temporary track did not consist solely of reballasting. Poor drainage and soil conditions caused the rapid decay of many of the wooden crossties. Tie replacement was an annual maintenance activity. (SRDAR, 1925-1945, and ETSAR, 1946-1950). Standard-sized ties made from either fir or tamarack were used to replace rotten ties. Although new ties were generally used, the ERR occasionally used ties that had been salvaged from reconstructed sections of permanent track. (SRDAR, 1925, p. 5) Beginning in the 1930's, the ERR began to install tie plates on replacement ties. This was done because it was thought that the use of tie plates would prolong the useful lives of the ties, thereby reducing the need for tie replacement. (SRDAR, 1933) A minimal quantity of new rail was used in the repair of temporary track. When rails on temporary track broke or wore down to the point that they could no longer be used, they were replaced by rails either salvaged from abandoned

lines, or by rails removed from permanent track during reconstruction. (SRDAR: 1925, p. 5; 1933; and SRDPTR, 1935)

The term "temporary track" was used to describe all unpaved street railway track that was constructed between 1908 and 1922, with the exception of the tracks on the High Level Bridge. While some sections of temporary track had been replaced by permanent track during that period, low ridership as well as economic conditions precluded most temporary track lines from being replaced by permanent track. (Yorath, 1924, p. 44) By the mid 1920's, it became apparent to the ERR that the term "temporary track" was no longer appropriate. City officials, including ERR management, began using two new terms to describe the unpaved track. The variously-used terms were "open track" and "skeleton track". (SRDAR, 1928-1945, and letter from the City Engineer to the City Commissioners, June 8, 1937)

The maintenance of open track did not include only tie, ballast and rail replacement. After several years of use, most rail heads required grinding in order to remove flanges of metal and corrugations (periodic gouging of the top of the rail head) caused by the repeated movement of streetcar wheels over the rails. (Harding & Ewing, 1926, pp. 281-283) Grinding of rails began in late 1937 when the ERR introduced its rail-grinding car. (SRDMR, November 1937, and ERR Plan of Rail Grinder Mechanism, 1937) A detailed description of the rail grinder may be found in a subsequent chapter. (Also see Appendix I)

Although new extensions of open track were constructed between 1926 and 1949, the maintenance and repair of these extensions was carried out using the methods described in this section.

Permanent Reconstruction, 1923-1927

Reconstruction and repair during this period, was undertaken only on those sections of permanent track in serious need of such work. The reconstruction ranged from the replacement of pavement to complete reconstruction starting from a new base. (SRDAR, 1924-1927) In 1925, for example, a section of double-track on 82nd (Whyte) Avenue between 100th Street and the CPR tracks was completely rebuilt. The original 1909 concrete base was broken up and removed. A new base, using the 1913 standard, was then constructed. (SRDAR, 1925, p. 5) The rest of the reconstruction basically followed the methods introduced in 1916. There were, however, several notable changes. The rail used in the 1925 reconstruction of 82nd Avenue was 60 pound per yard (24.9 kg/m) ASCE T-rail, instead of the previously-used 80 pound per yard (33.2 kg/m) ASCE T-rail. (CEED Drawing of Detail of Pavement at Rail, September 1923) As a consequence of using the smaller rail, the filler strip and wooden blocks placed against the outside edges of the rails were smaller. (See Figure 16) The filler strip used in this construction was a standard 1 inch by 2 inch (25.4 mm X 50.8 mm) board, painted with hot asphalt or mastic. The two wooden blocks were also smaller, being only 3 inches square (76.2 mm^2). The blocks were not supported by tapered concrete but by a 1 inch (25.4 mm) thick board that could have a width from 5 to 8 inches (127 mm to 203 mm). All wood surfaces were painted with asphalt or mastic. It should be noted, however, that the rail was not painted. Figure 17 (after CEED Drawing of Detail of Pavement at Rail, September 1923) shows the appearance, in cross-section, of track reconstructed according to the previously described method.

Some sections of permanent track did not require complete reconstruction. The rails along Jasper Avenue between 104th and 108th Streets

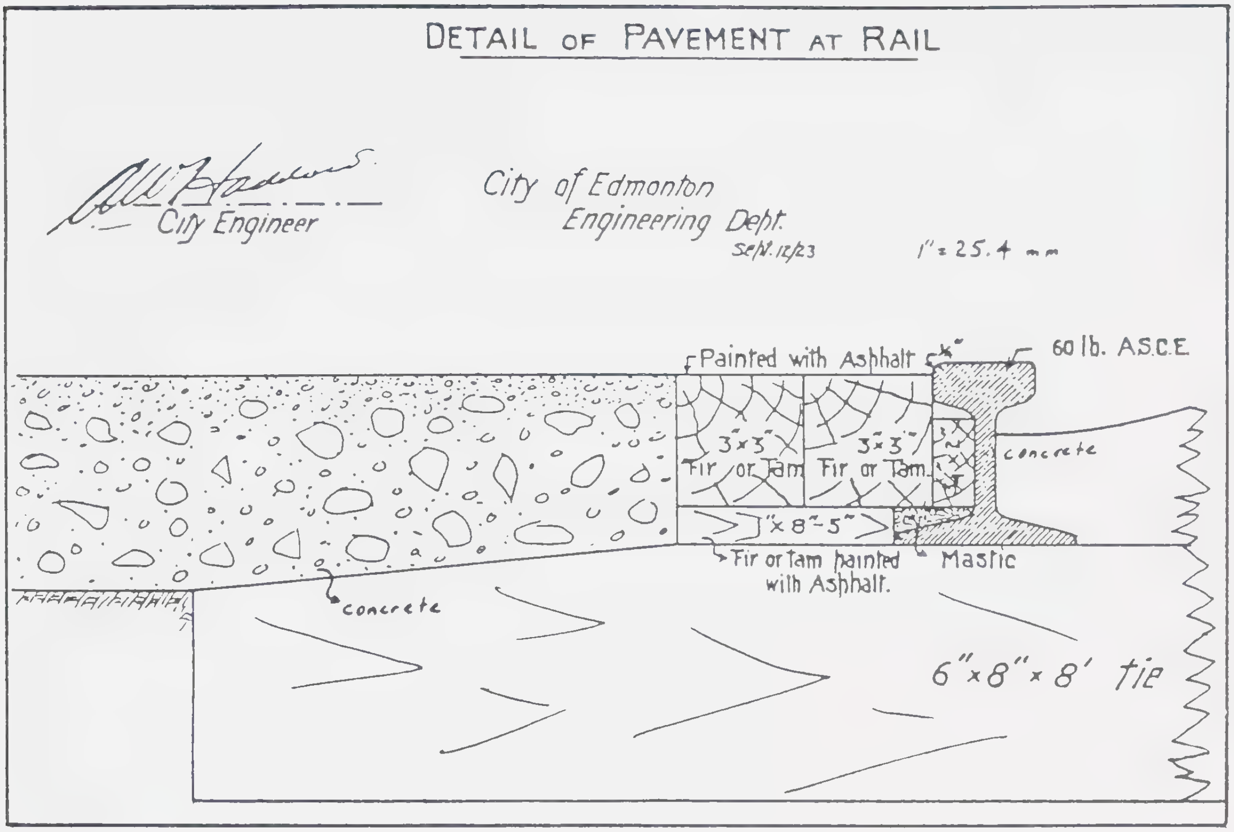


FIGURE 17. PAVEMENT USED IN 1923-1927 RECONSTRUCTION

had become worn at the ends and this was interfering with the smooth and safe operation of the streetcars. In this instance, the only work required was the replacement of the rails and the pavement. This work was carried out during 1924 and 1925. (SRDAR, 1925, p. 5) Repairs were also made to special work. It had been mentioned in an earlier section that some special work had been replaced in 1916 and in 1917. Most of the special work that had been replaced was ten years old. By 1924, the majority of ERR permanent special work was ten years old and was showing signs of wear. The ERR and the City were unwilling to spend large sums of money to replace the special work. To prolong its usefulness, the ERR repaired the worn parts by arc welding. In this process, manganese steel welding rods were used to build up worn sections

of the special work. (SRDAR, 1926, p. 2, and SRDGL, Account T)

The repair of special work and the reconstruction of portions of permanent track postponed the need for the reconstruction of large sections of permanent track. If the ERR intended to provide reliable and safe service in the future, however, major reconstruction of permanent track had to take place.

Permanent Construction, 1925

In 1924, the Canadian National Railways (CNR) and the City of Edmonton began the construction of a roadway underpass (sometimes referred to as a subway) on 101st Street between 104th and 105A Avenues. The purpose of the underpass was to allow the CNR tracks to cross over 101st Street without interfering with the movement of streetcars, road vehicles and pedestrians. Streetcar service on 101st Street was disrupted while the underpass was under construction. (Canadian Railway and Marine World, November 1925, p. 568)

By mid 1925, the construction of the tracks through the underpass could take place. Although the tracks were to be straight, the sub-grade dipped to provide clearance between the streetcars and the bridge carrying the railroad tracks. The standard concrete slab was used for the base. Standard-sized ties were also used. These ties, unlike the ties used in previous construction, were coated with either asphalt or creosote. (Provincial Archives of Alberta Photograph A. 2374) ASCE T-rail was not used. Although the track travelled in a straight line horizontally, it curved vertically. As a safety measure, therefore, grooved girder guard rails were used in the construction. The rails were manufactured by the Lorain Steel Company and carried the designation 98-451. This type of rail weighed 98 pounds per yard (40.6 kg/m). (Lorain catalogue 22, Tramway

Rails, 1927, p. 85) Figure 18 (after Lorain catalogue 22, Tramway Rails, 1927, p. 85) shows a cross-section through Lorain 98-451 rail. The height of the rail should be noted. The rails on 101st Street, approaching the

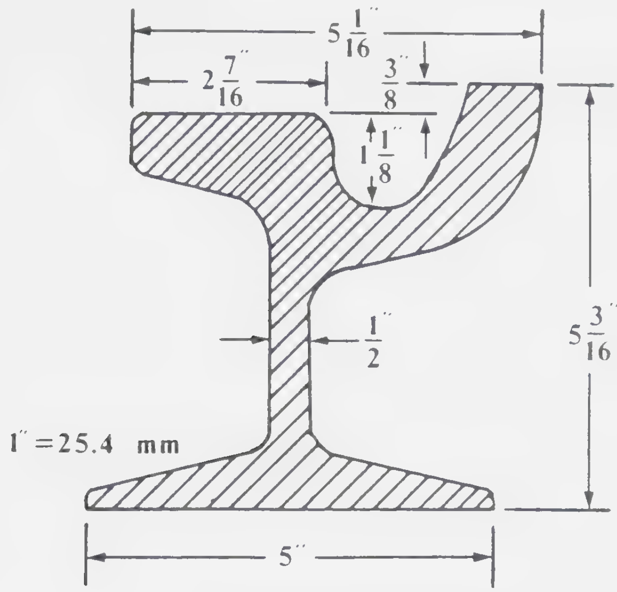


FIGURE 18. CROSS-SECTION OF 98-451 GUARD RAIL

underpass, were 80 pound per yard (33.2 kg/m) ASCE T-rails. Both the Lorain rail and the ASCE rail were 5 inches (127 mm) high. By using Lorain 98-451 rail, instead of the previously-used Lorain 108-398 rail, the ERR avoided the use of special compromise rail joints that were prone to breakage. Continuous rail joints, employing three track bolts per rail section, were used to connect the lengths of rail together.

After the ties and rail were in place, special drains were installed near and at the bottom of the underpass. These drains were designed to carry away any water that would flow into the underpass. To facilitate the draining of the rail flangeways, holes were burned through the sides of the guard lips, by workmen using oxy-acetylene cutting torches, at

the locations of the drains. (Letter from ERR Superintendent W. J. Cunningham to City Commissioner D. Mitchell, June 6, 1929)

The paving method used was similar to that described in the section dealing with track reconstruction between 1923 and 1927. Special filler blocks were required because of the profile of the grooved girder guard rail. (CEED Drawing of Detail of Rail Filler for Lorain Section 98-451, March 1925) In addition, flangeways did not have to be formed in the concrete because the rails already provided flangeways. Plate 11 (Provincial Archives of Alberta) shows two stages of construction of the underpass tracks. The photograph was taken on July 14, 1925 from the bottom of the underpass. The photographer was facing north towards 105A Avenue. The left hand track had been constructed on the concrete base recently. Workmen are installing the wooden blocks along the edges of the right hand track in preparation for the final layer of concrete. The drain and the rail joints should be noted.

Track Removal, 1925

By 1925, most of the ERR's freight spurs were no longer in use. Some customers found that their supplies could be transported by other means, such as trucks, at lesser cost than the ERR. In addition, some customers had moved or had gone out of business. The new companies occupying the property either did not require the services of a freight spur or did not wish to use the street railway. (SRDAR, 1925, p. 5) A total of three freight spurs were removed: the spur into the City yards from 95th Street; the spur to the former premises of Robarts and Boon, also on 95th Street; and the spur to the Graves Lumber Yard, located on 118th Avenue. (SRDAR, 1925, p. 5)

ERR crews also removed the single temporary track along 106th

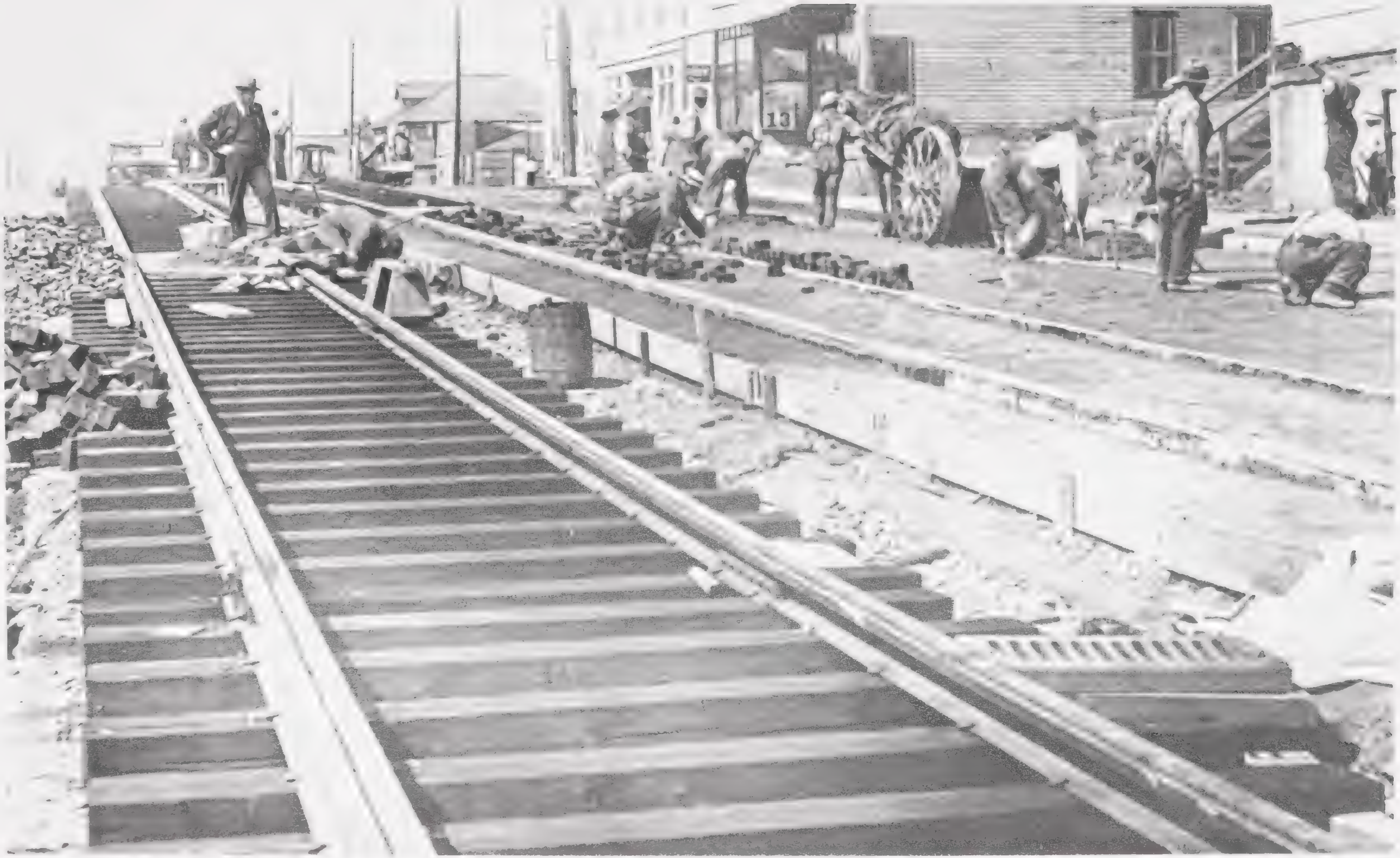


Plate 11. (Provincial Archives of Alberta) Track Construction Approaching 101st Street Subway, 1925

Avenue (formerly Sutherland Street) between 95th and 97th Streets. The track was removed because it had been out of service for several years. (SRDAR, 1925, p. 5) It should be noted that the special work located at 97th Street was not removed because to do so would have required the removal of pavement on 97th Street. This would have resulted in the disruption of service on that street. (SRDAR, 1925, p. 5)

Signal System, 1925

In 1923, the ERR and the CNR approached the BRC with a proposal to install an automatic signal system at the ERR/CNR crossing at 107th Avenue at 121st Street. The signal system was to consist of two colored light signals and an electric "wig-wag" road signal. (CNR Drawing of Proposed Automatic Flagman, October 1923) The BRC eventually gave its approval for the automatic signal system and it was installed during 1925. (SRDAR, 1925, p. 6) The operation of the signal system was similar to the operation of the block signal used on Strathcona (formerly Ross) Road during 1912. A streetcar approaching the CNR crossing from either side faced a signal that could display either a green or a red light. Both signals normally displayed a red light. As the streetcar approached, its trolley wheel would touch a contactor that would, if the railroad track was clear, cause the signal to display a green light. In addition, a circuit would be closed that provided power to a motor that would move the derails away from the rail heads. The streetcar could then proceed through the crossing. On the other side of the crossing, the streetcar's trolley wheel would touch another contactor that would reset the signals and the derails. If a train approached the crossing, its wheels closed a circuit in an insulated portion of the rail. This circuit locked

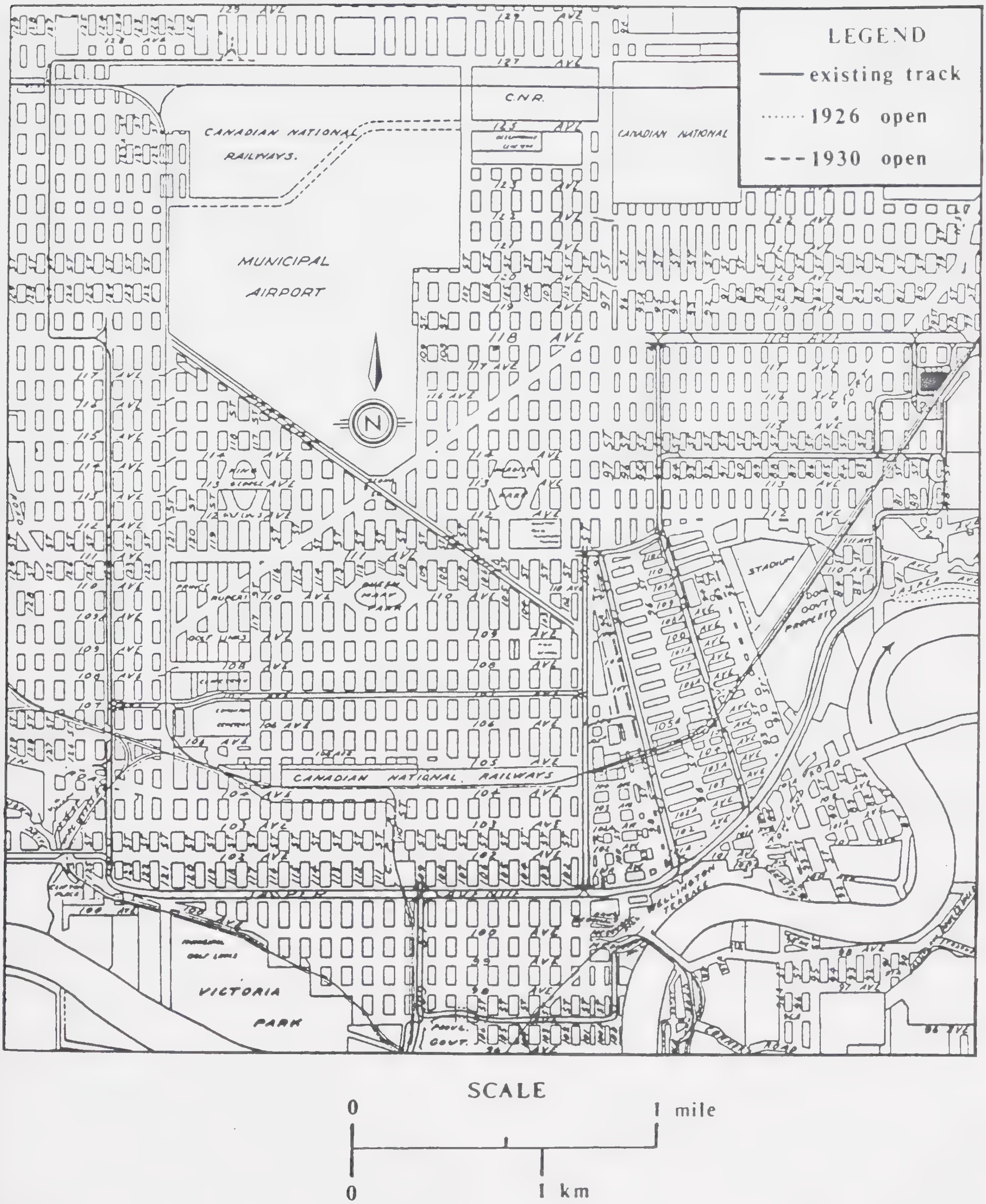
the ERR signals on red, and activated the "wig-wag" road signal. A wig-wag consisted of a tall steel pole with a box mounted on the top. Another pole extended from the side of the box. This pole held a circular target with a red light in its centre. When the wig-wag was activated, the red light would turn on and the target would swing back and forth, hence the name wig-wag. Wig-wag signals were designed to warn pedestrians and motorists of the imminent approach of a train.

Open Track Construction, 1926

Although no new extensions to open track were contemplated, improvements to existing open track were a priority. The single-track line to Calder (127th Avenue), north of 118th Avenue, had no sidings. Only one streetcar at a time, therefore, could use this section of track. Since the ERR wished to increase the service on this line, a passing siding (turnout) had to be constructed to enable streetcars travelling in opposite directions on the line to pass each other. A siding was constructed on 127th Street from a point several yards (metres) north of 126A Avenue to a point several yards (metres) south of the right hand curve leading onto 127th Avenue. (SRDAR, 1926, pp. 2-3, and ERR drawing of 127th Street Track, North of 126th Avenue, March 1927) The siding may be seen on Map 12.

Open Track Removal, 1926

In an effort to reduce both maintenance and the risk of derailments, the ERR altered the arrangement of the special work at 80th Street and 116th Avenue which lead into the streetcar barns. Part of the special work was removed, so that only one track remained between the barns and 116th Street. Track crews also removed the track on 78th Street



MAP 12. EXTENT & TYPE OF CONSTRUCTION 1926 – 1930

between the streetcar barns and 118th Avenue. (SRDAR, 1926, pp. 2-3)

Permanent Reconstruction, 1928-1936

The permanent track reconstruction of 1923 to 1927 had been undertaken only as a means to keep tracks in serviceable condition and to postpone the reconstruction of long sections. (SRDAR, 1926, p. 2) By early 1927, it was apparent to Superintendent Cunningham that the complete rebuilding of heavily-used sections of permanent track had to take place as soon as possible. Cunningham stated,

> We are endeavouring by means of minor replacement and welding where necessary to delay the time of track and rail replacements on a large scale. It will however, be necessary in the near future to entirely renew the rails in some of the heavy traffic sections. (SRDAR, 1926, p. 4)

Cunningham was able to persuade the City Commissioners and the City Council to approve extensive permanent track reconstruction plans by the end of 1927. The reconstruction was approved because of several factors. One significant factor was that most of the permanent track was actually in poor condition.

Several complaints had been received by the ERR and the City Commissioners about the poor track condition. (Correspondence between Superintendent Cunningham and the City Commissioners, May 1926-August 1927) In one instance, a resident complained of damage to his house from vibrations produced by the banging of streetcar wheels over a piece of special work adjacent to his house. This complaint was lodged after the Street Railway Department had repaired (by welding) worn parts of the special work. (Correspondence between the City Commissioners and Superintendent Cunningham, May 29 and June 2, 1926) Superintendent Cunningham further reported that the problem could not be resolved

unless the existing pavement and special work were replaced. (Report to the City Commissioners from Superintendent Cunningham, June 2, 1926)

Another factor that encouraged the start of a permanent track reconstruction program was the large increase in ridership on the ERR during 1927. (CEAR, 1928, p. 23) Cunningham thought that improvements in operation might not only prevent a drop in ridership, but might also serve to further increase ridership. (CEAR, 1928, p. 22) In addition, the increasing revenues earned by the ERR in recent years had offset previously large yearly deficits. (SRDAR, 1926, p. 1)

The construction method used in the 1928 to 1936 reconstruction program was, essentially, the concrete slab method that was first introduced in 1913. The 1928 to 1936 construction method included several changes, however. The first step of reconstruction consisted of the removal of old track and the original concrete roadbed. The existing sub-grade was then tamped and rolled. A new base layer of concrete was then deposited and allowed to set in preparation for the placement of ties. Except for special work, standard-sized fir ties were placed on the hardened concrete, spaced 2 feet (0.61 m) centre to centre. Each tie was treated with creosote before being placed on the roadbed. (CEED Drawing of Street Railway Double Track Construction, February 1928) A new type of rail fastening device was introduced in 1928. In previous years, rails were fastened to the ties by track spikes which were pounded into the ties. If a rail required replacement, the spikes could be pulled out, a new rail installed and the spikes replaced. The replaced spikes did not, however, hold the rail firmly. In addition, the hammering required to drive the spikes into place frequently split the ties, rendering them useless. To alleviate these problems, screw spikes

were used. Screw spikes were threaded fasteners which were designed to be turned, by means of a wrench, into holes drilled into the ties. The shoulder of a screw spike head was bevelled so that it could grip the base of the rail effectively. It was widely believed that screw spikes could facilitate rail replacement because this type of fastener could be removed and replaced several times without damaging the existing ties. Screw spikes, therefore, could hold rails firmly to the ties in a more effective manner than ordinary track spikes. The major disadvantage of screw spikes was their higher cost. (Harding & Ewing, 1926, p. 273) Figure 19 (after CEED Drawing of a Standard Screw Spike, December 1930) shows the basic appearance of the type of screw spike used by the ERR in permanent track from 1928. The metric conversion as well as minor deletions were made by the author.

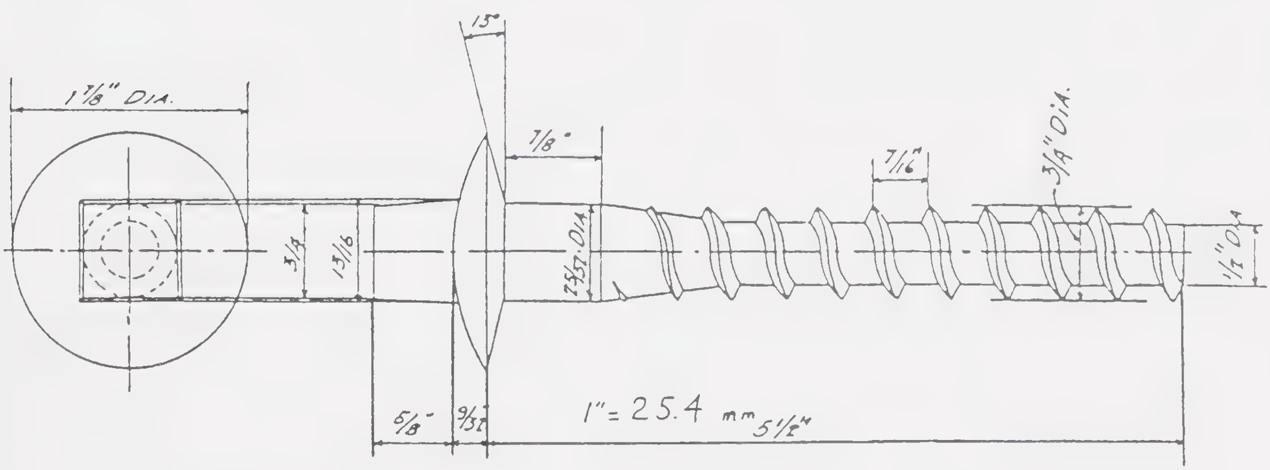


FIGURE 19. SCREW SPIKE

In addition to the use of screw spikes, the ERR began to use tie plates. (CEED Drawing of Street Railway Double Track Construction, February 1928) The tie plates, which were designed to prolong the life

of the ties, rested on top of them and had two holes to accommodate screw spikes. The holes were placed so that they would match holes that had been drilled in the ties. It should be noted that the holes in the ties had been drilled before the ties had been placed on the roadbed. The holes in the ties were so placed that when the rails were secured to the ties, the rails would be aligned to the proper gauge. The rails were fastened to each tie by two screw spikes, one on each side of the rail. Figure 20 (after CEED Diagram Showing Tie Boring and Tie Plates, July 1934) shows a standard tie ready for installation. Minor alterations were done by the author. After the prepared ties and tie

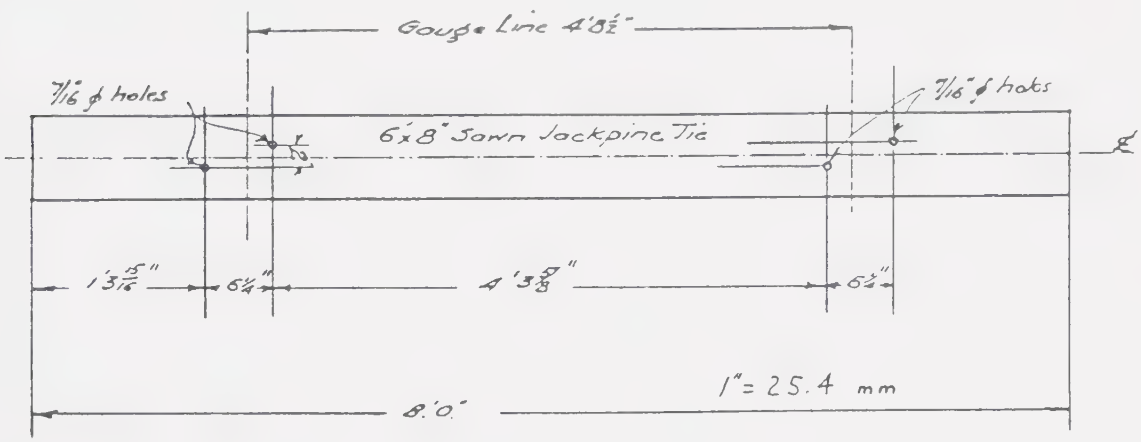


FIGURE 20. TIE BORING LAYOUT

plates had been placed on the roadbed, lengths of rail were placed on top.

Grooved girder rail was used instead of ASCE T-section rails. (CEED Drawings Showing Track Construction, 1928-1936) Although ordinary grooved girder rail was similar in appearance to grooved girder guard rail, the lip of plain grooved girder rail was designed to provide a

flangeway only and was not intended to act as a wheel guard. The flangeways of grooved girder rail were also designed to enable snow and ice in the grooves to be forced out to the side by the passing of streetcar wheel flanges. (Cyclopedia of Applied Electricity, 1908, p. 84) This feature provided grooved girder rail with a distinct advantage over the previously-used ASCE T-rail and concrete flangeway that was not self-clearing.

Two brands of grooved girder rail were purchased between 1928 and 1936. The first, and most widely used brand, was type 103-287A, manufactured by the Bethlehem Steel Company of Bethlehem, Pennsylvania. The second brand was the Lorain Steel Company's type 103-478. (CEED Drawings of Track Construction, 1928-1936) Both rail types were identical in appearance and both weighed 103 pounds per yard (42.7 kg/m). It should be noted that in 1932 both rail types were modified slightly in order that they conform to standards set by the American Electric Railroad Engineers' Association. The modified rails had thicker bases so the total weight per yard was increased to 104 pounds (43 kg/m). (CEED Drawing of Rail Filler for Bethlehem and Lorain Grooved Girder Rails, March 1932) In spite of the change, several drawings prepared by the City Engineers after 1932 continued to refer to the rails by their former weight. Figure 21 (after CEED Drawing of Lorain 103-478 and Bethlehem 103-287A Rails, February 1929) shows the cross-sectional appearance of the two grooved girder rail types used by the ERR between 1928 and 1936. The height of the rails should be noted. Most of the reconstruction rebuilt sections of track in central Edmonton that had been constructed with high-T rail. Some of these sections were to be relaid with high-T rails. In addition, most of the special work rails were the same height as the high-T rail so the connecting grooved girder rail

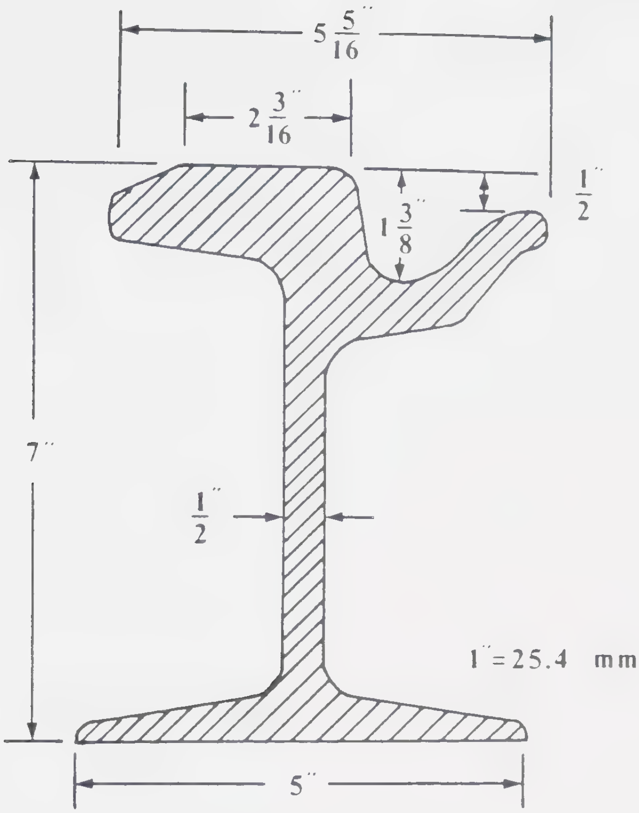


FIGURE 21. CROSS-SECTION OF 103-478 AND 103-287A GROOVED GIRDER RAILS

lengths should be the same height. Although there were compromise angle bars that could join shorter grooved girder rail to taller rail sections their use was discouraged because they allowed excessive vertical movement of the rails at the joints. Premature rail wear was the result of this vertical movement. (Harding & Ewing, 1926, pp. 280-281) The ERR also introduced a new method of fastening rail sections together. Various types of angle bars had been used since 1907 but each type had allowed considerable vertical movement between rail lengths. A type of "continuous" welded joint was used to overcome the problem of wear at the rail ends.

The "Thermit process" began with crews butting the ends of the rail lengths together and placing two halves of a mold box around the

joint. The mold box surrounded both sides of the rail and the bottom, leaving the top exposed. The mold box was usually fabricated from steel and was filled with either casting sand or refractory material that had a cavity for the welding material. (Doane & Parkham, 1926, § 19 pp. 24-25) When the mold box had been secured to the rails with clamps, the mold cavity was filled from the top with a mixture of finely powdered iron oxide (Fe_2O_3) and aluminum. (Dover, 1929, p. 533) A thin strip of magnesium metal was then placed in the mixture and set on fire with an open flame. The heat of the burning magnesium caused an exothermic reaction to occur between the aluminum and the iron oxide. The resulting temperature, between 5,000° and 6,000°F (2 760°-3 316°C), was sufficient to melt the iron and the adjacent steel in the rails. This provided a uniform, rigid and complete bond between the two rail lengths. (Dover, pp. 533-534) Thermit welds were considered to be stronger than any electric or oxy-acetylene welded joint. (Correspondence between Superintendent Cunningham and the City Commissioners, June 1928-July 1929) Following the completion of the thermit welding, the rails were attached to the ties. It should be noted that angle bars and track bolts were used to join old sections of rail as well as special work to the new grooved girder rails. (CEED Drawings of Track Construction, 1928-1936)

A system of track drains was installed at this time. They were designed to remove water from the track area as well as from the rail flangeways. In order for the flangeways to drain, notches were burned into the rail lips with oxy-acetylene cutting torches at locations where there were track drain boxes (receptacles). (Letter from Superintendent Cunningham to Commissioner D. Mitchell, June 6, 1929) Following the completion of the trackwork, the area was paved, completing the reconstruction. Although the use of the 1923-1927 paving method was continued,

the final surface of the pavement consisted of a 2 inch (51 mm) thick layer of asphalt instead of concrete. (CEED Drawing of Street Railway Double Track Construction, February 1928) Table 2 (after: SRDAR, 1928-1936; SRDPTR, 1934-1936; and CEED Drawings of Track Construction, 1928-1936) lists the year and the location of permanent track reconstruction between 1928 and 1936. No special work is included in this table.

Table 2 Reconstructed Permanent Track, 1928-1936

Year	Location
1928	*-97th Street, between Jasper and 103rd Avenues
	*-101st Street, between Jasper Avenue and lane north of 102nd Avenue (n.b. the Y at the lane was removed at this time)
* These sections were extensively repaired in 1929. (see text below)	
1929	-Jasper Avenue, between 101st and 104th Streets
1930	-Jasper Avenue, between 104th and 109th Streets
	-82nd Avenue, between CPR tracks and 105th Street
	-97th Street, between 103rd and 105A Avenues (this included a roadway underpass) (the special work at 97th Street and 106th Avenue was removed at this time)
1931	-Jasper Avenue, between 95th and 97th Streets
	-95th Street, between 111th and 114th Avenues
	-101st Street, between 105th and 107th Avenues
	-118th Avenue, between 88th and 95th Streets
	-124th Street, between 101st and 102nd Avenues
	-High Level Bridge (new ties and screw spikes only)

1932	-97th Street, between 108th and 111th Avenues -118th Avenue, between 80th and 88th Streets -Rat Creek (Kinnaird) Bridge (bridge deck only)
1933	None
1934	-95th Street, between 114th and 118th Avenues
1935	None
1936	-97th Street, between 105th and 108th Avenues

The winter of 1928-1929 revealed a serious problem with the track reconstruction of 1928. When the ambient temperature fell below -40° F (-40°C), the rails sheared apart where notches had been burned in the rail lips. The shearing was caused by the contraction of the rails at the low temperatures. Thermit joints, unlike angle bar joints, did not permit any longitudinal movement of the rail sections. In addition, cutting notches in the rails with a cutting torch had drawn the temper from the rails at those points. The stress caused by the low temperatures was, in most instances, sufficient to shear the rail where it had been weakened. (Letter from Superintendent Cunningham to City Commissioner Mitchell, June 6, 1929) In his letter of explanation to the City Commissioners, Superintendent Cunningham stated that the decision to adopt Thermit joints was made after careful consultation with other street railways located in cold climates that used the Thermit joint. Cunningham also stated that none of the street railways experienced such low temperatures as those in Edmonton. The Superintendent desired the continued use of the Thermit joint so a solution to the shearing problem had to be found. The sheared rails were repaired by crews electrically welding

angle bars to the sides of the rails at the locations of the breaks. In future construction, holes were drilled (rather than notches cut) through the lips of the rails. (Letter from Superintendent Cunningham to Commissioner Mitchell, June 6, 1929) The modification appears to have worked since there were no further reports of sheared rails.

The permanent reconstruction of 1928-1936 also included several pieces of special work. In previous reconstructions, either new pieces were installed or the entire special work unit was replaced. This was not always done, however, between 1928 and 1936. In some instances, parts of the existing special work had not been used, while other parts had been worn out by heavy use. The grand union at 109th Street and Jasper Avenue is a good example of this. The northern parts had rarely been used, while most of the southern parts were in constant use. In such a case, the track crews dismantled the special work and replaced the worn sections with the unused parts of the special work, if this were possible. (CEED Drawings Showing Special Work Reconstruction, February 1928-July 1936) Table 3 (after: SRDAR, 1928-1936; correspondence between Superintendent Cunningham and the City Engineers, 1928-1936; and CEED Drawings Showing Special Work Reconstruction, 1928-1936) lists the year and the location of special work reconstruction between 1928 and 1936. The table also describes the appearance of the special work and describes whether the special work was rebuilt or replaced.

Table 3 Permanent Special Work Reconstruction, 1928-1936

Year	Type and Location	Work Done	Appearance
1928	-Three-part Y at 101st Street and Jasper Avenue	New parts on 101st Street only	Same
	-Three-part Y at 97th Street and Jasper Avenue	New parts, left-turn track on 97th Street removed	Modified
1929-1930	None		
1931	-Three-part Y at 101st Street and Jasper Avenue	New parts on Jasper Avenue only	Same
	-Three-part Y at 95th Street and Jasper Avenue	New unit, left-turn track on 95th Street omitted	Modified
	-Three-part Y at 95th Street and 111th Avenue	New unit	Same
	-Three-part Y at 95th Street and 118th Avenue	New unit, left-turn track on 95th Street omitted	Modified
	-Right Hand Branch-off at 95th Street and 114th Avenue	Used parts from 95th Street and 118th Avenue	Same
1932	-Grand Union at 109th Street and Jasper Avenue	Used parts from grand union; northern tracks removed as well as left-turn track on 109th Street	Modified resembled left hand branch-off
1933-1936	None		

Open Track Construction, 1930

The single-track line to Calder (127th Avenue) had been a stub line (a line without facilities for turning streetcars at its terminal) since the time it had been leased from the EIR in 1916 (see Map 11). Only double-end streetcars could use the line because of the lack of a Y or a loop at the terminus. Most of the ERR's streetcars had been converted to single-end operation by the mid 1920's so there were few double-end streetcars available. In addition, many of the single-end streetcars had a rear smoking area, a feature desired by many patrons of the Calder line. Although plans had been proposed as early as 1926 for the conversion of the Calder line to single-end operation, no action was taken until 1930. (Correspondence between Superintendent Cunningham and the City Commissioners, June 1926-August 1929) The City Commissioners and Superintendent Cunningham both decided that a Y was the least expensive means by which turning facilities could be provided. The Y was installed at 118th Street. (SRDAR, 1930, p. 3) In order for the single-end streetcars to be turned at the other terminus of the Calder route, a new Y was installed at the intersection of 95th Street and 106th Avenue. (Letter from Superintendent Cunningham to the City Commissioners, March 13, 1933) It should be remembered that there had been a Y at that location in the past but it had been removed in 1921. (SRDAR, 1921)

In an effort to improve streetcar operation along Strathcona Road, crews moved the passing siding that was located near the southern end of the Low Level Bridge. The siding was moved further south to a point adjacent to Connor's Road. (Canadian Railway and Marine World, September 1930, p. 592) The new location of the siding was thought to provide motormen with an unobstructed view of the entire single-track line on

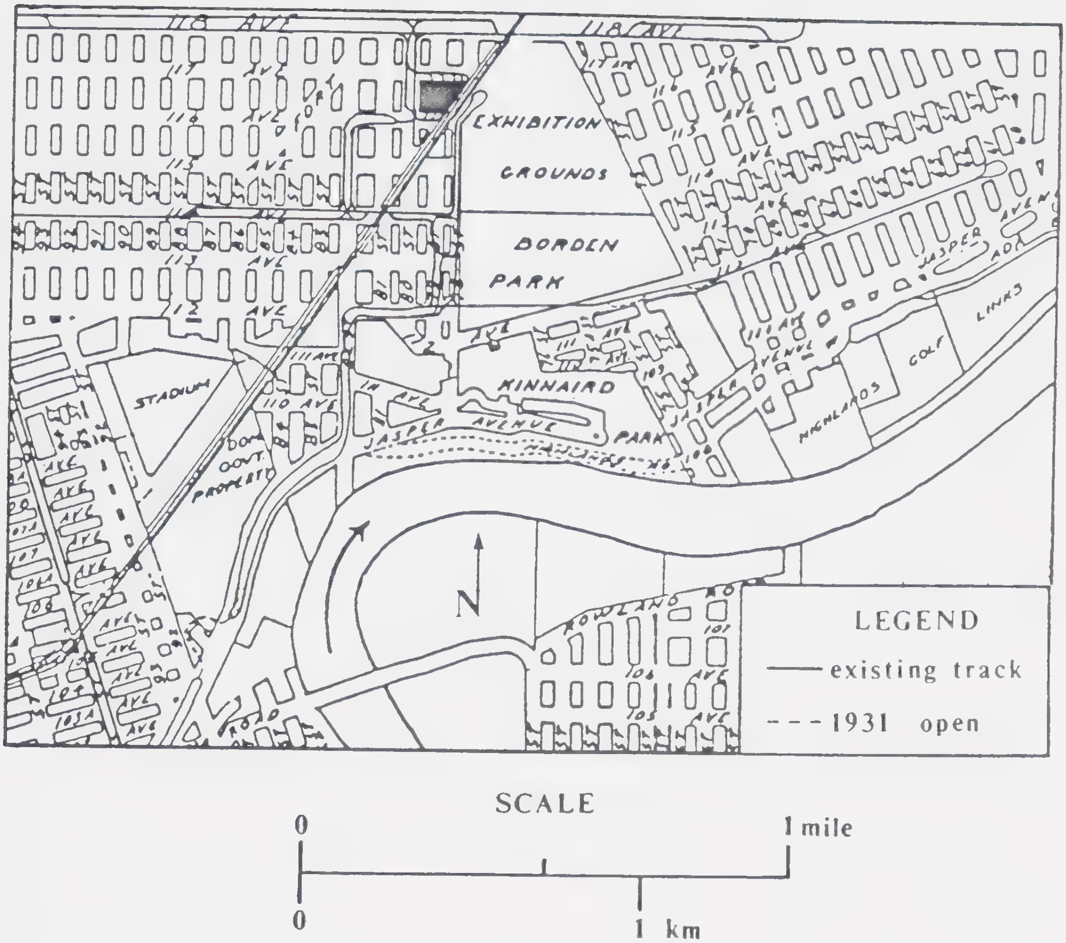
Strathcona Road.

The locations of the open track construction of 1930 may be seen on Map 12.

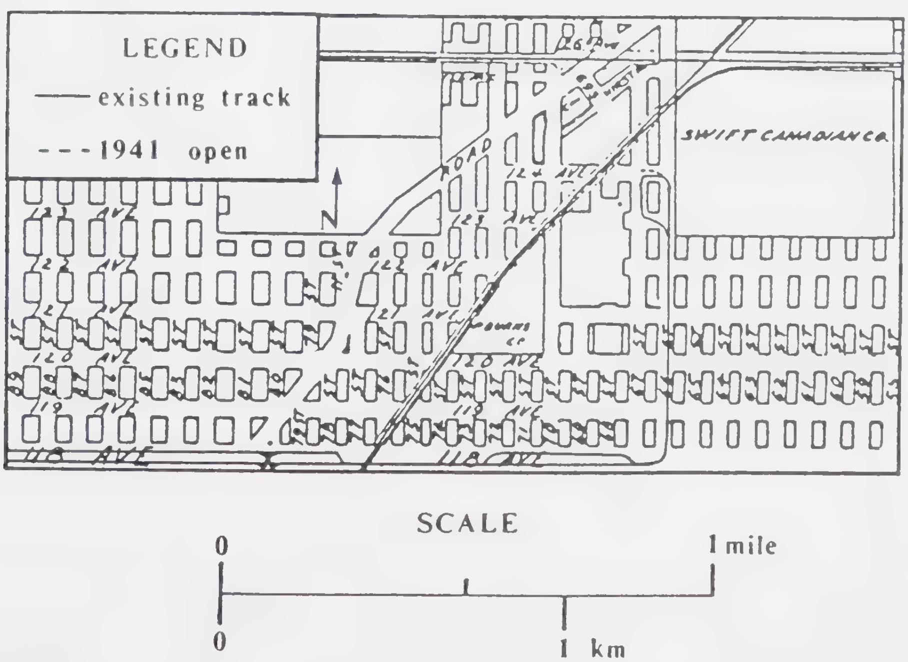
Open Track Construction, 1931

During the year, substantial reconstruction of the Highlands (112th Avenue) line between 78th and 62nd Streets took place. The reconstruction provided track crews with an opportunity to add additional passing sidings. (SRDAR, 1931, and Canadian Railway and Marine World, January 1931, p. 44) While the original siding at 68th Street remained, two new sidings were constructed. One was located near 75th Street and the other was located near 72nd Street. It should be noted that tie plates were used in the construction of these open track sidings. (CEED Drawing of Track System, 1936, and photograph by R. J. Walker, 1944) The locations of the sidings may be seen on Map 13.

Although the maintenance and construction of bridges was not the responsibility of the Street Railway Department, the safe operation of its streetcars was. The ERR management was concerned when the City Engineer stated that the condition of the trestle bridge over the Latta (formerly Penitentiary) Ravine (located on Jasper Avenue west of 92nd Street) had deteriorated to such an extent that streetcars could no longer use it. (Letter from City Engineer Haddow to the Elk's Club, October 10, 1931) The City Engineer did not wish to have the bridge replaced immediately. In addition, Superintendent Cunningham did not wish to have streetcar service disrupted along that portion of Jasper Avenue. Engineer Haddow proposed a "temporary" solution to the problem. He proposed to construct a diversion. The diversion was to start a few yards (metres) before either end of the bridge was reached. The track



MAP 13. NORTHEAST CONSTRUCTION, 1931



MAP 14. NORTHEAST CONSTRUCTION, 1941

was to travel north a sufficient distance to avoid the Latta Ravine entirely. After reaching the "head" of the Ravine, the track was to parallel Jasper Avenue for a short distance, through private property, and then turn south to join the track approaching the opposite end of the bridge. (CEED Drawing of Proposed Diversion, October 1931) Although the diversion was considered to be temporary, tie plates were used in the construction. (Photograph of Diversion by R. J. Walker, 1944) The diversion was completed and placed in operation in 1922. (SRDAR, 1932, p. 2) The completed diversion, which resembled a semi-ellipse, may be seen on Map 13. It should be noted that the so-called "temporary diversion" remained in use until that section of the track was abandoned in 1945, although a new bridge of steel construction was built in 1936. (Letter from Commissioner Mitchell to City Solicitor Garside, March 12, 1936, and photograph of the diversion by R. J. Walker, 1944)

Track Removal, 1932

For several years, Superintendent Cunningham had urged the City Council to authorize the abandonment of several unprofitable and under-used stub lines. As early as 1928, Cunningham had proposed that less expensive service to the areas served by the stub lines could be provided by replacing the streetcars with either trolley or motor buses. (Letter from Superintendent Cunningham to the City Commissioners, September 20, 1928) Although both types of buses required sound roadways, expensive track was unnecessary and was, therefore, eliminated. The City Council, as well as many citizens, repeatedly opposed Cunningham's proposals for the abandonment of street railway tracks. One stub line that Cunningham wished to abandon was the track on 102nd Avenue west of 124th Street. There were two bridges on the line and the one at

131st Street was in dire need of reconstruction. (Letter from Superintendent Cunningham to the City Commissioners, January 27, 1932) Cunningham had asked the City Council in December 1931 for authorization to purchase several motor buses, one of which was needed if service on 102nd Avenue was to continue while the bridge at 131st Street was being rebuilt. City Council eventually authorized the Street Railway Department to purchase the required motor buses. (Letter from the City Clerk to the City Commissioners, January 29, 1932)

The City Engineer had been insisting on the closure of the 131st Street bridge for some time since the bridge was in danger of collapsing. The bridge crossed a ravine that was both deep and long. It was, therefore, not possible to construct an inexpensive track diversion around the bridge. A motor bus replaced the streetcar service on 102nd Avenue on January 25, 1932. On the same day, the City Engineer closed the bridge at 131st Street, effectively preventing the reinstatement of streetcar service. (Letter from Superintendent Cunningham to the City Commissioners, January 27, 1932) The replacement bus service was deemed successful and the track on 102nd Avenue was removed later in the year. (SRDAR, 1933, p. 2) The introduction and use of a vehicle that did not require an expensive and fixed roadbed was to have detrimental effects upon the street railway and its development in the future.

Permanent Reconstruction, 1937-1943

Between 1933 and 1936, the amount of permanent track reconstructed was far less than the amount reconstructed between 1928 and 1932. (See Table 2) In the 1935 Street Railway Department Annual Report, written in June 1936, Acting Superintendent Ferrier warned City officials of the dangers of postponing further permanent track reconstruction,

"I would like to point out that the permanent reconstruction of several sections of main line track must be faced very soon as the longer this construction is postponed the cost of maintenance will become higher and higher until it is prohibitive" (p. 2). Thomas Ferrier was appointed Acting Superintendent after the sudden death of Superintendent W. J. Cunningham on May 13, 1934. (Edmonton Journal, May 14, 1934, p. 1) The ERR obtained permission to have two sections of permanent track reconstructed. The tracks to be reconstructed were located on: 97th Street, between 108th and 111th Avenues; 111th Avenue, between 95th and 97th Streets. (CEED Drawing of Street Railway Double Track Construction, May 1937) Although the basic construction method used in 1937 was the same as the method used between 1928 and 1936, the 1937 reconstruction used shorter and heavier grooved girder rails. A major disadvantage of using tall rails was that unless paving blocks were used, large amounts of paving material were required to raise the level of the road to the tops of the rail heads. (Cyclopedia of Applied Electricity, Vol. III, pp. 84-85) In addition, rail corrugations seemed to be found more on tall rather than short grooved girder rails. (Harding & Ewing, 1926, pp. 282-283) The new type of grooved girder rail used was Bethlehem 105-418 which had a weight per yard of 105 pounds (43.6 kg/m). This rail, while being shorter than the grooved girder rails used previously, had both a wider head and base. The added width accounted for the greater weight of the new rail. (CEED Drawing of Street Railway Double Track Construction, 1937) Figure 22 (after CEED Drawing of Bethlehem 105-418 Rail, 1937) shows the appearance of Bethlehem 105-418 rail in cross-section.

The method of paving used between 1928 and 1936 was modified slightly in 1937. Instead of using wooden filler strips next to the rails,

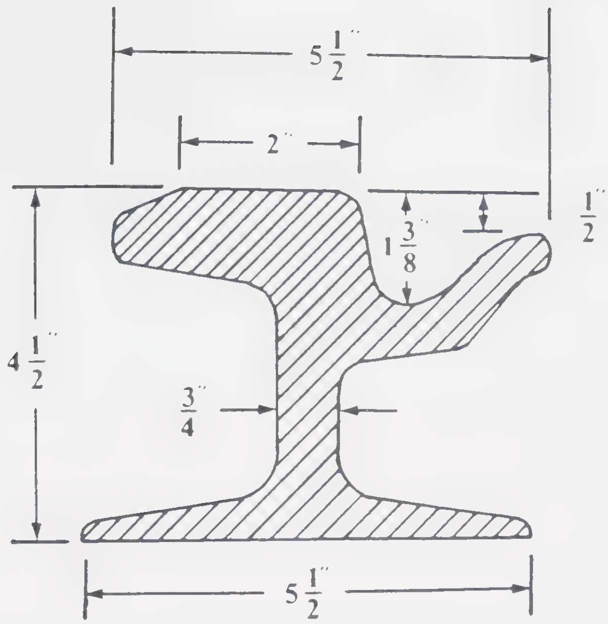


FIGURE 22. CROSS-SECTION OF BETHLEHEM 105-418 GROOVED GIRDER RAIL

fine concrete was poured around them. The concrete filler was also used around rebuilt special work rails. (CEED Drawing of Street Railway Track Construction, 1937) The use of concrete as a filler eliminated the problems experienced with the shaping, fitting and replacing of the wooden filler strips. It should be noted that the rest of the paving and construction methods and materials used in 1937 were identical to those used between 1928 and 1936. (CEED Drawings of Track Construction, 1937)

The year 1937 marked the end of extensive track reconstruction on the ERR. On December 22, the City Commissioners presented a report to the City Council that dealt with future developments of the street railway. The report stated that while some permanent reconstruction had taken place, almost two thirds of the permanent track had not been reconstructed. In addition, the report stated that the reconstruction

already done had been the main cause of the exceedingly large capital deficit. (CECR, December 22, 1937, p. 2) The report recommended that consideration be given to the greater use of other types of vehicles, specifically motor and trolley buses. The report also recommended that further permanent track reconstruction be postponed until a rehabilitation program could be found that would not increase the capital debt of the ERR. (CECR, December 22, 1937, pp. 1-4) Additional support for the curtailment of reconstruction came in 1938. The report of a consulting firm recommended that no further reconstruction be done since another recommendation called for the eventual elimination of streetcar service. (Wilson & Bunnell, 1938, p. 1) The ERR adopted the report's recommendations, so track reconstruction plans were abandoned. In the 1938 Annual Report, Superintendent Ferrier stated, "One reason why no reconstruction work has been carried on this year is that the Department intends to convert certain routes from street car to electric trolley bus operation" (p. 9). Although no reconstruction of permanent track took place between 1938 and 1942, the three-part Y at 101st Street and Jasper Avenue was replaced, for the third and final time, during 1943. The special work was replaced because it had worn out and was beginning to interfere with the operation of the streetcars. (SRDAR, 1943, p. 2)

Apart from minor repairs and maintenance, no permanent track reconstruction took place between 1944 and the end of streetcar operations in September 1951. (SRDAR, 1944-1945, and ETSAR, 1946-1949)

Open Track Construction, 1939-1941

In 1938, the ERR and the City administration decided to introduce trolley buses (sometimes referred to as trolley coaches) on certain routes that were being served by streetcars. (CEAR, 1938, p. 9) Trolley buses,

while not requiring an elaborate roadbed, did require paved roadways in order to operate efficiently. (CEAR, p. 9) The initial route proposed for trolley bus operation included crossing the Low Level Bridge. The bridge deck, as well as Strathcona Road, were both in dire need of reconstruction. (Wilson & Bunnell, 1938, p. 17) In 1939, following the recommendations of Wilson and Bunnell (1938), the ERR constructed an open track loop on 99th Avenue a short distance east of 100th Street. The construction of this loop ended streetcar service over the Low Level Bridge and enabled crews to repave the deck of the bridge in preparation for trolley bus service. (p. 18) Trolley buses were not the only reason, however, for new open track construction.

In October 1941, the ERR introduced library streetcar service to several outlying districts. (SRDNMR, October 1941, p. 1) This service, provided by a rebuilt passenger streetcar, required special parking sidings in order to avoid interference with other street railway traffic. Initially, the library streetcar visited the Calder and North Edmonton districts. (Canadian Railway and Marine World, November 1941, p. 623) To accommodate the library car at Calder, a short open track extension was constructed on the northern leg of the open track Y on 127th Avenue. (Provincial Archives of Alberta Photograph PA-454/1) For its visits to North Edmonton, a short open track stub-siding was constructed from the loop track located on 124th Avenue. (Palmer, Mitchell and Holcomb, 1950, p. 2) Map 14 (after Official Map of the City of Edmonton, 1938, and Palmer, Mitchell and Holcomb, 1950, p. 2) shows the location of the stub-siding for the library streetcar at North Edmonton. While the use of new vehicles brought about the construction of some open track, the effects of the Second World War would bring about substantial open track construction.

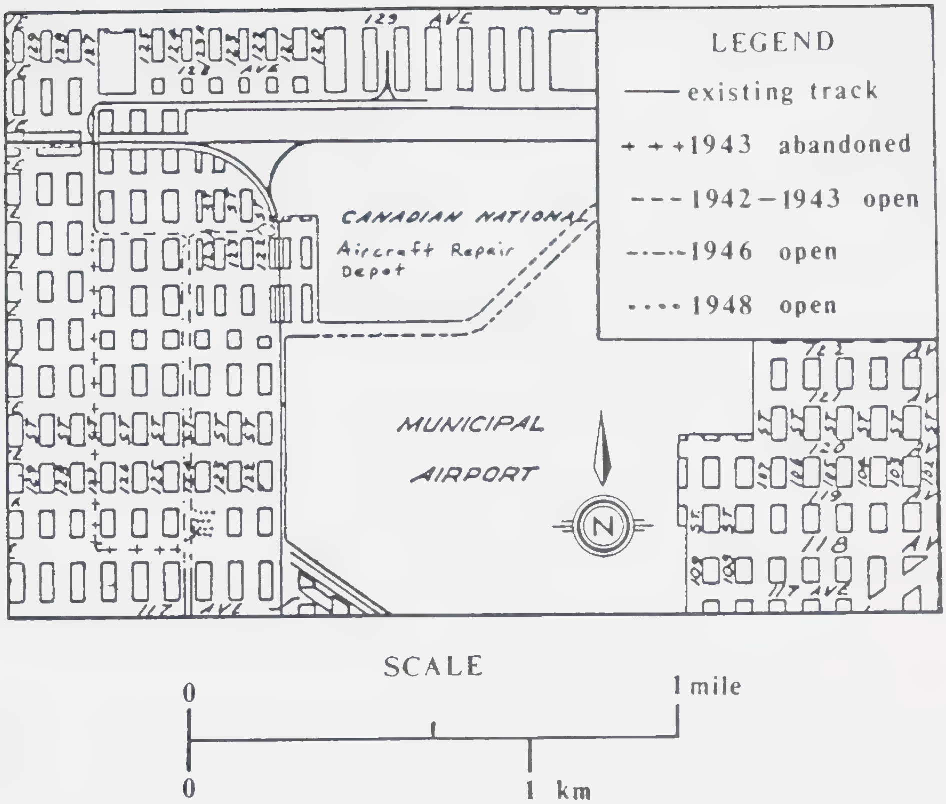
Open Track Construction, 1942-1943

The Second World War, unlike the First World War, did not induce a drop in ERR ridership. The very opposite was true. Between 1940 and 1942, the ridership increased approximately 40%. (SRDAR, 1940-1943) The increase in ridership as well as wartime difficulties in obtaining buses effectively postponed the ERR's plans for the abandonment of streetcar service. There was also a demand for street railway service at the aircraft repair depot that was located on 125th Avenue near the railroad yards. (See Map 14) Although the depot was being served by motor buses, more workers at a time could be transported to and from the depot by streetcar. Several routes were proposed for the new streetcar line to the aircraft repair depot. One proposal advocated the use of the permanent double-track on Kingsway (formerly Portage) Avenue that had never been used. In another proposal, a single-track line of open track construction was to be built along 124th Street between 118th and 125th Avenues. At 125th Avenue, the track was to have a switch that would enable a streetcar to turn either east or west. The eastern track was to be built at a location near the aircraft repair depot where it would terminate in a loop. The western track was to connect with the existing single-track line on 127th Street (the Calder line). The proposal also called for the removal of the existing track on 127th Street between 125th and 118th Avenues (part of the old EIR). (CEED Map of Proposed Street Railway Extensions, July 1942) The Dominion Transit Controller, a Federal wartime position, gave approval to the latter proposal and construction began in the fall of 1942. (SRDAR, 1942, pp. 1-2 and Edmonton Bulletin, November 7, 1942) The trackage to the area of the aircraft repair depot was completed by the end of February 1943. (Edmonton Bulletin, February 22, 1943) Although the methods and the materials

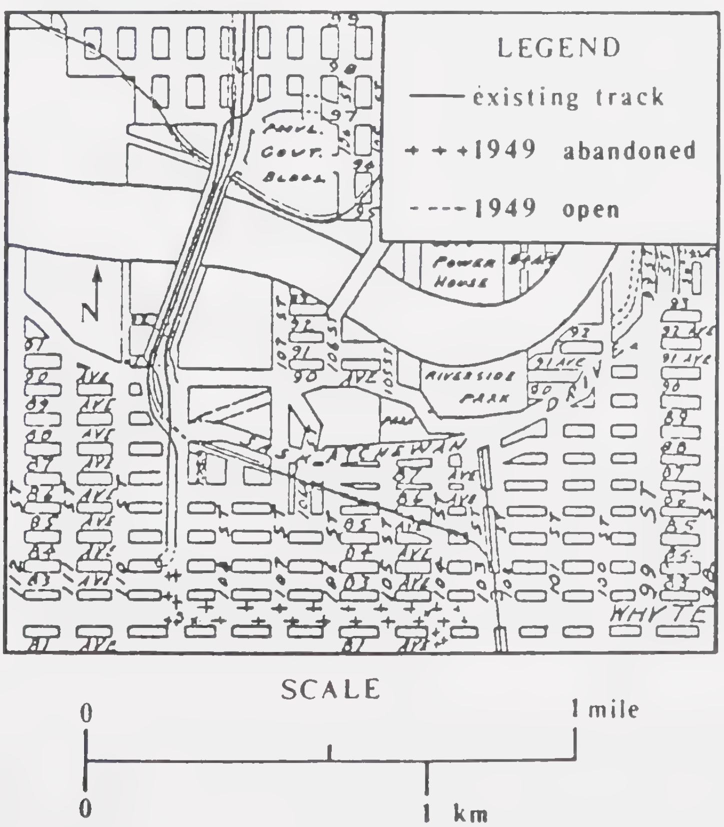
used in this open track construction were unchanged from those used in previous years, the season in which construction took place was changed. In the past, most track construction terminated when cold temperatures and snow arrived. The halt in the construction of the line to the exhibition grounds during the winter of 1919 is an example of this practice. (Edmonton Journal, January 5, 1920, p. 1; see also a previous section, Temporary Construction, 1919-1920) The construction of the new line to the aircraft repair depot proved that open track construction could continue during the winter months if absolutely necessary. In March 1943, following the completion of the new track, ERR crews removed the old, and now unused, track from 124th Street. (Edmonton Bulletin, March 23, 1943) Map 15 (after Official Map of the City of Edmonton, 1938, and CEED Map of Proposed Street Railway Extensions, July 1942) shows the location of the open track construction of 1942-1943.

Open Track Construction, 1946

The population of Edmonton, as well as ridership on the ERR, increased greatly after the end of the Second World War. In addition, during 1946 the names Edmonton Radial Railway and Street Railway Department were replaced by the name Edmonton Transportation System (ETS), which reflected the street railway's increasing use of buses. (ETSAR, 1946, p. 1) The final elimination of streetcar service was delayed, however, by the increase in ridership and because of difficulties in obtaining enough buses to replace the streetcars. One streetcar line that could not readily be replaced by buses and which required more frequent service was the single-track line to Calder. In order to increase service and in order to avoid the problems associated with passing sidings, the ETS constructed a second open track along 124th Street which paralleled the



MAP 15. NORTHWEST CONSTRUCTION, 1942–1948



MAP 16. CENTRAL CONSTRUCTION, 1949

single open track constructed during 1942 and 1943. Construction commenced at 118th Avenue and proceeded north to a point several feet (metres) south of the switch at 125th Avenue where it connected with the other track. Unlike the construction of 1942-1943, the 1946 construction was carried out during the spring and summer months. (ETSAR, p. 1) The location of the track constructed in 1946 may be seen on Map 15.

Open Track Construction, 1948

By 1948, the conversion to bus operation and the consequent street railway track abandonments were causing noticeable effects on street railway operations. One new trolley bus line, for instance, was to travel north along 124th Street to a loop at 118th Avenue. Part of the program to prepare trolley bus routes consisted of paving the streets that the trolley buses would use as well as the removal of any open construction streetcar tracks on those roads. It was planned, therefore, to remove the existing streetcar tracks on 124th Street between 107th and 118th Avenues and then to pave 124th Street in preparation for trolley bus service. (CECR No. 15, April 26, 1948, p. 1, and CEED Minutes of 1948 Paving Program Meeting, January 14, pp. 1-2) The removal of the tracks on 124th Street south of 118th Avenue meant that the tracks to Calder (north of 118th Avenue), which were still in use, would be isolated from the rest of the street railway system. The operation of the Calder section, while considered to be temporary, required the construction of storage and service tracks since the nine streetcars assigned to that section could not return to the streetcar barns. A set of four spur tracks, one of which doubled as a Y, were constructed on a lot located on the east side of 124th Street immediately north of 118th Avenue. (CECR

No. 15, April 26, 1948, p. 1)

One of the streetcars assigned to the Calder section was the library streetcar. (CECR No. 15, p. 1) Before the isolation of the Calder line, that streetcar had also served North Edmonton. In order for the library streetcar to provide better service to the people along the Calder section, a new stub-siding was constructed south from 125th Avenue along 127th Street. (Palmer, Mitchell & Holcomb, 1950, p. 2) The location of the Calder storage and service tracks as well as the library streetcar stub-siding may be seen on Map 15.

Open Track Construction, 1949

After the Second World War, the number of private automobiles in use in Edmonton increased greatly. (Wilson, 1949, pp. 1-10) In his report to the City on his assessment of the ETS (referred to as the Edmonton Transit System since 1947), Wilson stated that the turning of streetcars at 104th Street and 82nd Avenue by means of the three-part Y was a dangerous practice because there was heavy automobile traffic at that intersection. (p. 21) Wilson recommended that an open track loop be constructed on a lot located on the east side of 109th Street north of 82nd Avenue. (p. 21) While the City followed Wilson's basic recommendation, the loop was constructed on the east side of 109th Street immediately south of 84th Avenue. (CECR No. 2, March 28, 1949, p. 2) The Wilson Report of 1949 also recommended a streetcar route change. The change included the termination of one route at the north end of the High Level Bridge. To enable streetcars to turn near this location, Wilson recommended, and the City crews constructed, an open track loop at 98th Avenue between 109th Street and the CPR tracks. (Wilson, 1949, p. 2) These two open track loops, which may be seen

on Map 16, were the last sections of street railway track to be constructed for the ETS. Street railway service ended in the early morning of September 2, 1951 and the construction and the maintenance of street railway track was no longer a concern to the ETS. In the following months, various City crews removed the remaining sections of open and permanent track, with the exception of several large pieces of permanent special work. In subsequent years, as the pavement covering them wore away, portions of these pieces of special work were visible once again. (Author's Observations and Photographs)

Chapter IV

Electric Power Production and Distribution, 1908-1981

Introduction

In Chapter II, it was stated that as early as 1893, some fourteen years before construction began on a municipally-owned street railway system in Edmonton, a Territorial Ordinance specified that electrically powered vehicles could be used on a municipally-constructed street railway in Edmonton. (Ordinances of the North-West Territories, 1893, No. 32, p. 279) Later, in 1904, the Town of Edmonton agreed to allow a private company to attempt the construction and operation of a street railway in the Town. The Agreement specified that the streetcars were to be powered by electricity which was to be distributed by a system of overhead wires. The Agreement, furthermore, stipulated that the electricity was to be returned to the electrical generator through "suitable conductors", such as the rails. (Memorandum of Agreement [Revised], between the Town of Edmonton and the Edmonton Street Railway Company, 1904, pp. 5-7; see Chapter II for further information about the Ordinance of 1893 and the history of the Edmonton Street Railway Company) By 1907, when the City of Edmonton started the construction of a municipally-owned street railway, most other street railways in North America were powered by electricity. (Burch, 1911, pp. 2-11) The predominance of electrically powered street railways, as well as the fact that Edmonton's power plant was owned by the City, were decisive factors in the selection of electricity as the source of power for Edmonton's street railway. (CEAR, 1908, p. 93)

The development of street railway electricity production in Edmonton can be divided into three overlapping periods, mechanical generation,

electrical rectification, and electronic rectification. The first of these periods, mechanical generation, refers to the production of street railway Direct Current (D.C.) by means of mechanical devices such as engine driven generators and generators driven by Alternating Current (A.C.) and D.C. motors. This period spanned the years 1908 to 1951. The second period, electrical rectification, began in 1929 and continued until the time of this research. "Electrical rectification" refers to the use of electrical devices, specifically mercury-arc rectifiers, to convert (rectify) A.C. into D.C. for use with streetcars and trolley buses. The third period, electronic rectification, began during the mid 1970's and was in use when this study was completed. The term "electronic rectification" refers to the use of high capacity solid state components (usually diodes) to rectify supplied A.C. into a D.C. suitable for use by trolley buses and by Light Rail Transit (LRT) vehicles. Although the periods of electricity production for use by vehicles of the ERR/ET overlap, a development from one type of D.C. production to another is easily discernible.

Mechanical Production, 1908-1910

When the City of Edmonton began the construction of the street railway in 1907, consideration was given to the type, size and numbers of generating equipments that might be required for the street railway. The most common voltages that were used on urban street railways in North America ranged between 550 and 600 volts D.C. The precise voltage was usually determined by the type of distribution system used. (Doane & Parkham, 1926, § 17 pp. 6-9) In addition, the most common form of power generation was by a D.C. generator driven by some form of reciprocating engine. (Cyclopedia of Applied Electricity, Vol. III, pp. 1-

5) Several manufacturers produced D.C. generators, each brand being similar in construction and operation. There were, however, many types of reciprocating engines that could be used to drive the generator. Early in 1907, the City Commissioners realized that the power plant in operation at that time, which was being operated with steam power, was being used to its capacity. The plant would have to be augmented in order for it to be able to supply the new street railway with electricity. (CECR No. 64, April 2, 1907, p. 1) In order to use additional steam engines to power the needed generators, an additional boiler would have to be obtained. In addition, in order to house the new boiler and steam engine, a new building would have to be erected. The City Commissioners, in an attempt to keep costs as low as possible, investigated alternate types of reciprocating engines. One type of engine that was widely used at that time was a large internal combustion engine that used a type of coal gas known as "producer gas". (CECR No. 64, April 2, 1907, pp. 2-6) The producer gas for the engine usually came from a gas producer and its gas storage reservoir which were located near the engine. A gas producer was a device that enabled hydrogen and carbon monoxide gases to be driven from a quantity of coking coal through a roasting process. Hydrogen gas and carbon monoxide gas were the main constituents of the producer gas. (Electric Railway Journal, May 14, 1910, p. 862) The main advantages of using a producer plant and gas engine over the traditional water boiler and steam engine were that the producer installation required less space and was thought to be more efficient. (CECR No. 64, April 2, 1907, pp. 2-6) One of the major disadvantages of producer gas engines was that they were not as powerful as steam engines of comparable size. This disadvantage, coupled with a long required delivery time, prompted the City Engineer and the City Commis-

sioners to purchase a producer gas engine and plant for uses other than those for the street railway. (CECR No. 64, April 2, 1907) The City Commissioners had anticipated that the new producer gas plant and engine would free a steam engine in the power plant that could be connected to the street railway generator. (CECR No. 105, December 17, 1908, p. 1)

In August 1908, when it became apparent that the street railway would be ready for operation before the end of the year, the City purchased one 300 kW, 550 volt D.C. generator from the Westinghouse Company. (CECR No. 15, February 1909) A 300 kW generator was purchased because it was thought to have a capacity in excess of what would be initially required by the street railway. (CECR No. 105, December 17, 1908, p. 1) The Westinghouse generator arrived by the middle of October. (Edmonton Journal, October 16, 1908, p. 1) The generator could not, however, be connected directly to a steam engine. The producer gas plant had not been completed by this time. All the power plant steam engines were needed to provide the necessary electrical power to the City. To overcome the shortage of steam engines and as a temporary measure, the street railway generator was arranged in the power house so that it would be driven by a steam engine through the use of a flat leather belt. The belt was placed over the flywheel of the steam engine to a pulley that was mounted on the shaft of the generator. As the flywheel rotated, the belt caused the shaft of the electrical generator to rotate. Since the flywheel had a larger diameter than the diameter of the generator pulley, the generator shaft rotated through more revolutions. While this arrangement enabled the generator to create some electrical power, its maximum output could not be achieved. The power that was needed by the generator to produce its

maximum output would have been sufficient to cause either one of two things to happen. The belt would slip or it would break, thereby disrupting service on the street railway. (CECR No. 105, December 17, 1908, p. 1) The single 300 kW generator had the potential for generating more power than what was required. It was not sufficient, though, to power the entire street railway.

All electrical conductors used in the street railway power distribution system, including the trolley wires and the rails, offered resistance to the flow of electricity. (Cyclopedia of Applied Electricity, Vol. III, pp. 92-94, and Dover, 1929, pp. 616-617) As a streetcar travelled away from the generator, the voltage in the trolley wire dropped. If a streetcar travelled several miles (km) away and no supplementary power was fed into the trolley wire, the voltage drop in the trolley wire would be sufficient to reduce the streetcar's speed and power noticeably. If the distance travelled was great enough, the voltage drop would be so great that the streetcar would not be able to move itself. The loss of electrical power in the distribution system, or line loss as it is commonly referred to, is more pronounced with D.C. than with A.C. (Doane & Parkham, 1926, § 17 p. 18) Line loss in D.C. circuits could be compensated for in several ways.

One way was to connect a copper cable with a much larger diameter than the trolley wire to the generator and run the cable to distant points along the trolley wire. On heavily-used lines, the cables were usually placed on poles that were placed alongside the streetcar line. The larger cable, being made of solid copper bar or stranded copper wire and having a greater area than the trolley wire, would offer less resistance to the flow of electricity. Less resistance also meant that there would be less line loss. The voltage in the larger cable, if measured half a mile

(0.8 km) away from the generator or further, would be higher than the voltage measured in the trolley wire at that point. The large cable, called a "feeder", was connected to the smaller trolley wire at frequent intervals by short lengths of copper wire. In this manner, the feeder would feed or boost the voltage in the trolley wire. The voltage of the trolley wire would, therefore, be kept as close to the generated voltage as possible. (Dover, 1929, pp. 618-624) In order for feeders to be fully effective, however, the rails, which provided the return path for the electricity used by the streetcars, had to be connected to other feeder cables, usually placed underground, which travelled from the rails to the generator. (Dover, pp. 618-624) Feeders used by themselves were ineffective and were uneconomical. A feeder's effectiveness was limited by distance. Although feeder cables were usually larger than trolley wires, they were subject to line loss like any other conductor. After a distance of approximately 2 miles (3.2 km), the voltage in the feeder would have dropped by such an extent that the trolley wire voltage would not be increased beyond that point. If the streetcar line continued for several more miles (km), power from another generator, usually located in a substation near the end of the line, would be required to prevent the trolley voltage from dropping too low, thus adversely affecting the operation of streetcars in that area. (Dover, pp. 618-624)

The use of substation generators in conjunction with feeders overcame the distance limitation that was inherent with feeders. Substations were usually placed at locations beyond the point where the feeders from the power house generator had any benefit. (Dover, pp. 628-630) Prior to the 1930's, all street railway substation generating equipment in Edmonton consisted of devices known as "motor generators". (Report to the City Commissioners from Power Superintendent W. J. Cunningham, November

22, 1928, pp. 1-2)

A "motor generator" consisted of a D.C. generator and an A.C. motor mounted on a common steel or cast iron frame. The shafts of the two units were coupled at one end. When the motor was energized, its shaft rotated. Because of the coupling of the two shafts, the shaft of the generator also rotated, thereby producing D.C. electricity. The output voltage of the generator was controlled by the speed of the motor in conjunction with a rheostat (a large variable resistor) that controlled the intensity (strength of the electromagnetic field) of the generator's field coils. (Harding & Ewing, 1926, p. 147) If, for example, the generator's output voltage was too high, a reduction of the voltage going through the generator's field coils would reduce the efficiency of the generator, thereby reducing its output voltage. If, however, the speed of the motor decreased to one-half its normal speed, for instance, the output voltage of the generator would fall to such a low level that adjustments to the setting of the rheostat would not raise the generator's output voltage to the acceptable level (550 to 600 volts D.C.). In order for a motor generator to maintain a steady output voltage, its performance had to be monitored by an operator located in the substation. By monitoring a voltmeter connected to the generator, the substation operator could either increase or decrease the strength of the generator's field coils by adjusting the rheostat as the numbers of streetcars using the track increased or decreased. This was done to maintain the voltage of the generator between 550 and 600 volts. (Harding & Ewing, p. 147)

The extension of the street railway tracks into Strathcona (located on the south side of the North Saskatchewan River) starting in August 1908 meant that the track located along Whyte (82nd) Avenue was beyond the effective range of the feeders from the power plant. (See Map 3

for locations) In order to prevent the streetcars from encountering power shortages at that location, the City purchased a 250 kW motor generator from the Canadian General Electric Company and placed it in a building located at Walter's Mill. (CEAR, 1908, p. 93, 1909, p. 105, and 1911, p. 133) Walter's Saw Mill was located on the riverbank in Edmonton near the power plant. (Mundy's Street Index Map to Edmonton, 1912) The motor generator was located close enough to the Strathcona track for its feeder to be effective. The feeder was connected to the Strathcona trolley wire at the intersection of Main (104th) Street and Whyte (82nd) Avenue. (ERR Drawing of Feeders and Track, 1912)

The protection of the generating equipment from the effects of short circuits and lightning was an essential consideration. A direct short circuit between the trolley wire and the rails would cause the maximum amount of current to flow through the circuit. This excessive current flow could seriously damage the commutator and armature of a generator if there was no circuit breaker present. A circuit breaker was placed in series between the positive terminal or bus bar of the generator and the trolley wire. Another circuit breaker was usually placed in series between the rail feeders and the negative terminal or bus bar of the generator. The circuit breaker would protect the entire circuit, including the generator, from damage. When excessive amounts of current were drawn in an extremely short time, a strong magnetic field would develop around a heavy coil inside the circuit breaker. This magnetic field would act as a solenoid and would pull an iron bar that was connected to a latch which held a moveable contact in place. When the latch was released, strong springs would force the moveable contact to open quickly, thus breaking the circuit. Before streetcar service could be resumed, the moveable contact had to be closed by hand and the

latch reset. The reclosing of a circuit breaker usually took place after the cause of the excessive current draw had been determined and corrected. (Doane & Parkham, 1926, § 17 pp. 7-9) Lightning, if it was allowed to reach the generator, could destroy the windings and the commutator. In addition, the varnish used to insulate the windings could be set on fire. To protect generating equipment from lightning, devices known as lightning arresters were connected in parallel between the ground and both the positive and negative feeder lines leaving the generating station. When lightning struck a trolley wire, a current surge usually travelled through the wire. As the surge approached the generating station, it would encounter a lightning arrester. One end of the arrester was connected to the feeder or to the trolley wire, and the other end was connected to the ground. An air gap or a dielectric within the lightning arrester prevented current from flowing through the arrester normally. The high current surge of a lightning strike would, however, tend to travel through the lightning arrester to ground, as the arrester provided a shorter path to ground than through the generating equipment. It should be noted that while most lightning surges were arrested entirely, some lightning strikes close to the generating equipment could be powerful enough to enable some of the surge to reach the generating equipment. (Harding & Ewing, 1926, pp. 150-157)

The ERR experienced power shortages and failures despite the system's 550 kW D.C. capacity. The producer gas plant and engine that had started working in November 1908 suffered from frequent shut-downs because of operational problems and required maintenance. (CECR No. 12, February 2, 1909) The producer engine was connected to a 50 kW, 120 volt D.C. generator which provided power to operate the pump motors for the City water supply. (CECR Nos.: 8, 1909, and 3, January 8, 1916)

When water demand was heavy or when the producer plant was shut down, power for the water pumps had to come from additional generators that were connected to the power plant steam engines. One of these steam engines was also connected to the 300 kW street railway generator. (CECR No. 105, December 17, 1908) The steam engine was not large enough to provide full power to both generators attached to it so when there was a high demand for electricity from the generator for the water pump motors, the speed of the steam engine dropped, resulting in a consequent drop in voltage of the street railway generator. Any drop in the speed of the steam engine meant that there would be a proportional drop in the speed of the street railway generator since that unit was connected to the steam engine's flywheel by a belt. Several press reports noted that streetcar service was frequently reduced, curtailed or interrupted by the failure of the gas producer and its engine. (Edmonton Journal, November 13, 1908, p. 1, November 21, 1908, p. 1, and December 14, 1908, p. 1) The situation was further compounded in December when the City Council and the Commissioners authorized the ERR to purchase more streetcars. No additional generating equipment was ordered until after the ERR received approval to purchase additional rolling stock. (CECR No. 105, December 17, 1908) The delay in ordering more generating equipment was to prove detrimental to the efficient operation of the ERR. Apart from observing the problems encountered with the generating system then in use, the City Commissioners had known since the beginning of November that the ERR was planning to double the number of streetcars in its fleet. The Superintendent of the ERR, C. E. Taylor, in the 1908 Annual Report which covered the period from December 1, 1907 to October 31, 1908, stated, "The indications are that the present passenger equipment will have to be doubled in the next

few months while express, baggage and freight cars are also likely to be added shortly" (p. 81).

The City Commissioners were of the opinion that steam engines were preferable to producer gas engines for any type of electrical production in view of the poor service, high cost and the perpetual maintenance of the producer plant and engine owned by the City. (CECR No. 12, January 26, 1909) After due consideration of the submitted proposals, the City Commissioners and the City Council authorized the purchase of two steam engines that would be used only for street railway power generation. One engine was ordered from the Belliss and Morcom Company of Birmingham, England and the other was ordered from the Robb Engineering Company of Amherst, Nova Scotia. Each engine was rated at 550 HP (410 kW) and both were of the vertical compound variety. (CECR Nos.: 105, December 17, 1908; 12, January 26, 1909) With a vertical steam engine, the cylinders were mounted vertically. The pistons, therefore, would also travel vertically. This arrangement meant that the crankshaft and the flywheel would be mounted on a horizontal plane. The term "compound" meant that the engine had two cylinders of different diameters and that steam, after passing through the first cylinder, was exhausted into the second cylinder before it was exhausted into a condenser for recycling. In the operation of a compound engine, steam from the boiler would enter the first of the two cylinders, which was the smallest. When the piston had travelled through one stroke either up or down, the steam would be exhausted into the second cylinder which was larger in diameter, thus compensating for the reduction of steam pressure. In this manner, the steam was used twice before it was recycled. (Air Brake Compressors, 1924, § 1 p. 40) The two steam engines required steam pressure of 165 lbs. per square inch (1 138 kPa) in order

to operate at maximum power. (Letter from Power Department Superintendent W. J. Cunningham to the City Commissioners, June 13, 1925)

By March 1909, the City Council and the Commissioners had approved the purchase of two generators that were to be connected to the steam engines. (Contract for two street railway generators with the Crocker-Wheeler Company, March 12, 1909) Two 400 kW, 575 volt D.C. generators were ordered from the Crocker-Wheeler Company. That company was selected because its cost for the generators undercut the nearest competitive bid by over $2,000.00 (CECR No. 13, February 1909) None of the new street railway generating equipment could be used, however, until the power plant was enlarged and the boiler capacity increased. This building and the equipment installation were not complete by the end of 1909. (CEAR, 1909, pp. 103-104)

Faced with an incomplete plant, additional streetcars being placed in service on the ERR and the continual failure of the gas producer plant and engine, the City purchased an additional 125 kW motor generator in 1909 which was installed at the power plant to supplement the output of the belted 300 kW generator. (CEAR, p. 103) In addition to those problems, the ERR ordered several more streetcars for delivery in 1910. (CEAR, p. 97) The electrical power shortages that the ERR had experienced in the past would continue. It should be noted that at this time the power generating equipment was purchased and operated by the Power Plant Department. (CEAR, pp. 104-105)

The steam engines and the two Crocker-Wheeler generators ordered in 1909 were placed in operation during 1910. In order for these two generators to generate 550 to 575 volts, the steam engines had to rotate the generators' shafts at the rate of 350 rpm. (PDAR, 1927) In addition to this installation, the original 300 kW Westinghouse generator that had

been belted to a steam engine flywheel, was directly coupled to a Robb Engineering Company 400 H.P. (298.4 kW) vertical compound steam engine that had been in use at the power plant for several years. This engine was made available by the installation of additional A.C. production equipment in the power plant. (CEAR, 1909, p. 104, and 1912, p. 196) The new generating equipment provided enough power for the ERR to operate all its streetcars within a determined radius of the power plant. In the 1910 Annual Report, the Superintendent of the Power Plant Department, P. McNaughton stated, "I believe that we have at present sufficient D.C. machinery to supply all demands of the Street Railway within the efficient transmitting radius for 550 volts. This radius may be said to be through Strathcona and north in Edmonton to the Norwood Boulevard [111th Avenue]" (p. 117). (See Map 4 for the location of the ERR tracks at this time) McNaughton also stated that the ERR would have to erect substations in northern Edmonton if it wished to extend its lines and wished to be able to increase the frequency of streetcars in areas outside the power plant's radius. (CEAR, p. 117) In anticipation of the ERR installing a motor generator at some distant point, McNaughton ordered additional A.C. producing equipment so that there would be adequate power for any new generating apparatus purchased by the ERR. (CEAR, pp. 117-118)

Power Distribution, 1908-1910

Before electric streetcars could operate on the track laid for them, some form of electrical distribution system had to be in place. Edmonton chose to use, as its means of supplying electricity to its streetcars, an aerially suspended bare wire that was located at a specific and constant height over the centre of the track. The tracks were to form the return

portion of the circuit. This type of distribution system was known as a "ground return" system. (Doane & Parkham, 1926, § 17 p. 3) It was mentioned in the previous section that D.C. was to be used. One characteristic of D.C. is that it has a constant direction of movement or polarity (positive and negative). At the time Edmonton's street railway was being constructed, the theory that electricity was the movement of electrons through a circuit from the negative terminal to the positive terminal of a power source was vaguely understood. The theory widely believed in at that time stated that in a circuit, current (the flow of electricity) passed from the positive end of the power supply to the negative end. (Cyclopedia of Applied Electricity, Vol. III, 1908) In the interest of clarity, the so-called "current-flow" theory will be followed unless otherwise stated.

The installation of the track usually took place before the installation of the overhead wires. (See Chapter III for descriptions of track construction methods) During the track construction before the pavement was constructed, consideration was given to the use of devices that would improve the conductivity of the rails. In Chapter I the hazards of electrolysis (the leakage of current from the rails through the ground and its consequent damage to buried metal fixtures and objects) were described. A voltage difference between the individual rails in a track was a major cause of electrolysis. To reduce the possibility of a voltage difference, heavy copper cables called cross-bonds were welded (bonded) to the base of each rail. Cross-bonds were installed at approximately 500 foot (152 m) intervals. In addition, if there was double-track construction, the two tracks were cross-bonded at intervals between the individual rail cross-bonds. (Doane & Parkham, 1926 § 19 p. 32) In addition to the use of cross-bonds, rail bonds were used by most street railways.

Rail bonds were short lengths of copper cable that were welded to the sides of the rail heads around each rail joint. The purpose of rail bonds was to provide a good current path around the rail joints, thereby reducing the likelihood of current leaking into the ground. (Doane & Parkham, § 19 p. 26) It appears that Edmonton installed cross-bonds on the earliest permanent construction of 1907-1908. Rail bonds do not appear to have been used. Plate 2 (Provincial Archives of Alberta) shows a section of permanent track under construction on Jasper Avenue in 1907. The labelled cross-bond should be noted as well as the absence of any rail bonds. It also appears that no bonds of any sort were used on temporary track (see Plate 6). The lack of rail bonds and the lack of bonds on temporary track not only increased voltage loss in the rails but allowed electrolysis to occur. Although the effects of electrolysis were not immediately apparent, it would cause the ERR perpetual problems in subsequent years. Following the completion of track construction, the overhead electrical wires could be installed.

The first trolley wires for use on Edmonton's street railway were made from solid copper bar that was drawn cold through steel dies so that it became grooved on two sides. Grooved trolley wire was available in several sizes. Edmonton selected the most common size in use, Brown and Sharpe gauge 2/0. (Letter from Eugene Phillips Electrical Works to the Edmonton Secretary-Treasurer, November 1, 1909) The trolley wire was grooved so that it could be securely gripped and supported by special clamps called "ears". (Doane & Parkham, 1926, § 18 p. 14, and Ohio Brass Catalog No. 23, 1940) Although round trolley wire was used in other installations and was available, its use was unpopular because the ears required for round wire had to extend around the sides of the wire. The added surface of the ears was usually sufficient so that they were

frequently struck by the passing streetcar trolley wheels (current collector). Over a prolonged period, the ears would be destroyed by this action, necessitating costly repairs to the overhead assembly. Grooved trolley wire, however, offered a completely smooth surface for the trolley wheels. (Doane & Parkham, 1926, § 18 p. 14) Before the trolley wire could be installed, segmented tubular steel poles or wood poles had to be placed along the route of the streetcar tracks at regular intervals. In addition, the poles had to provide some sort of support that was arranged perpendicular to the track in order that the trolley wire would be held in the correct position at the right height. The type of poles to be used and their placement was the first step in the construction of the street railway overhead. Edmonton used both segmented tubular steel poles as well as wood poles and employed three main types of trolley wire suspension: span-wire construction; centre-pole construction; and side-bracket construction. Span-wire construction consisted of a series of two poles placed at both sides of the road directly opposite each other. A braided steel wire called a "span wire" was strung across the road and was attached to each pole at a predetermined height above the surface of the road (see Plate 6). Centre-pole construction, which could be used only along straight sections of double-track, consisted of a series of single poles placed between the two tracks. Attached to these poles were steel tubes arranged so that they projected over each track and mounted on the poles (at a specified height above the tracks) so that they were parallel to the ground. The tubes were supported by truss rods and tubular angle braces. Each of these tubes had two steel castings attached to it. One casting was affixed to the end of the tube while the other was attached several inches (mm) away from the first casting. A short length of span wire was then attached to each casting (see Plate

12). Side-bracket construction consisted of a series of single poles placed along one side of a single or double track. A steel tube (bracket) was then attached to the poles in similar manner as in centre-pole construction. Steel castings and a length of span wire was also attached to the tube (see Plate 7). (Doane & Parkham, 1926, § 18 pp. 15-18) Besides knowing what type of pole and suspension methods to use, installing crews had to know how far apart each pole (or poles, in the case of span-wire construction) was to be. In the initial construction, the standard distance between poles was 100 feet (30.5 m), except in areas of curves or special track work where the distance between poles ranged from 89 feet to 117 feet (27 m to 35.7 m). (ERR Drawing Showing Position of Poles, 1908) The distance between poles was considered sufficient to support the trolley wire adequately without excessive lateral movement of the trolley wire. Pole length ranged from 30 feet to 32 feet (9.1 m to 9.75 m). For each pole, a 6 foot (1.8 m) deep hole was bored into the ground with hand powered augers. (ERR Drawing Showing Position of Poles, 1908) Crews, using ropes, horses and long, thin spiked poles (sometimes called "pikes"), would raise each pole and place it in the hole. The steel poles were held in place with concrete while the wood poles were usually held in place with tamped earth. When the poles were in place, crews could then install the span wires and/or bracket assemblies. In the case of centre-pole or side-bracket construction, commercially manufactured bracket assemblies (tubes, castings and braces) were used. (ERR Drawing of Trolley Poles and Brackets for Proposed Edmonton-Strathcona [High Level] Bridge, November 1911) Where span-wire construction was used, 5/16 inch (8 mm) diameter stranded galvanized steel wire was attached to the poles so that the centre of the wire was 16 feet (4.9 m) above the centre of the road. When centre-pole or side-

bracket construction was used, the brackets were placed on the poles so that the small length of span wire was 20 feet (6.1 m) above the centre of the track. The heights of the respective suspensions were within commonly accepted street railway standards. (ERR Drawing Showing Position of Poles, 1908, and Doane & Parkham, 1926, § 18 pp. 15-18) Following the completion of the pole and suspension installation, crews could begin the task of installing the trolley wire.

In the initial construction, one end of a spool of trolley wire was attached to a pole at one end of the line. The spool, mounted on a push cart, was wheeled along the track. As the trolley wire unreeled, crews with the aid of a wooden tower temporarily fastened it to the span wires with short lengths of small wire. It should be noted that the trolley wire was "dead" (not connected to any power source) at this time. (Doane & Parkham, 1926, § 18, p. 18) Plate 12 (City of Edmonton Archives) shows a crew stringing wire along the south track on Jasper Avenue at 100th Street in the summer of 1908. The steel centre-pole construction, wooden tower, push carts and the spool of trolley wire should all be noted. The installation of the trolley wire was far from complete. In order to prevent an extreme electrical hazard and in order to minimize line loss, the trolley wire had to be insulated from the span wire. This was accomplished by the use of "hangers". Hangers were galvanized malleable iron castings that were designed to be attached to the span wire. The middle of the hanger casting contained a stud (threaded rod) or a bolt that projected a short distance from the bottom of the casting. The remainder of the stud was surrounded by a rigid insulating material, usually porcelain. The stud and the insulation were held in place by a cap screwed onto the top of the casting. (Doane & Parkham, 1926, § 18 p. 23) The hanger stud was designed to hold an

Plate 12. (City of Edmonton Archives) Installing Wire Above Jasper Avenue, 1908

ear that would subsequently be attached to the trolley wire. Trolley ears, which were briefly explained earlier in this section, were castings that were designed to be screwed onto hanger studs and were also designed to be attached to the trolley wire. Trolley ears were usually cast of phosphor bronze or brass because these alloys resisted corrosion and wear and were also much stronger than ordinary copper. (Doane & Parkham, 1926, § 18 p. 24) There were two basic types of ears used, the plain ear and the feeder ear. The plain ear simply held the trolley wire to the hanger. The feeder ear possessed a lug that enabled a copper cable attached to the feeder to be connected to the ear. In this manner, feeder voltage reached the trolley wire. (Doane & Parkham, 1926, § 18 pp. 24-25) After the ears were installed on the hangers, the trolley wire was tightened with winches so that it did not sag. The ears were attached to the trolley wire by clinching (bending) the edges of the ear into the grooves of the trolley wire. Clinching was facilitated by the use of hammers and specially shaped steel anvil blocks known as "clinch blocks" which enabled hammer blows to be transmitted from the clinch block to the edges of the ear without damage occurring to the softer trolley wire. (Ohio Brass Catatlog No. 23, 1940, p. 108) Figure 22 (after Doane & Parkham, 1926, § 18 pp. 23-25, and Ohio Brass Catalog No. 23, 1940) shows the typical appearance of a completed hanger, ear and 2/0 grooved trolley wire installation. The hanger depicted is a representation of an Ohio Brass Company type D straight line hanger. Although other brands of overhead materials were used, the products of the Ohio Brass Company of Mansfield, Ohio were most frequently used. (Letter from Canadian General Electric Co., Canadian importer of Ohio Brass products, to C. E. Taylor, ERR Superintendent, September 8, 1909, and artifacts in the author's collection)

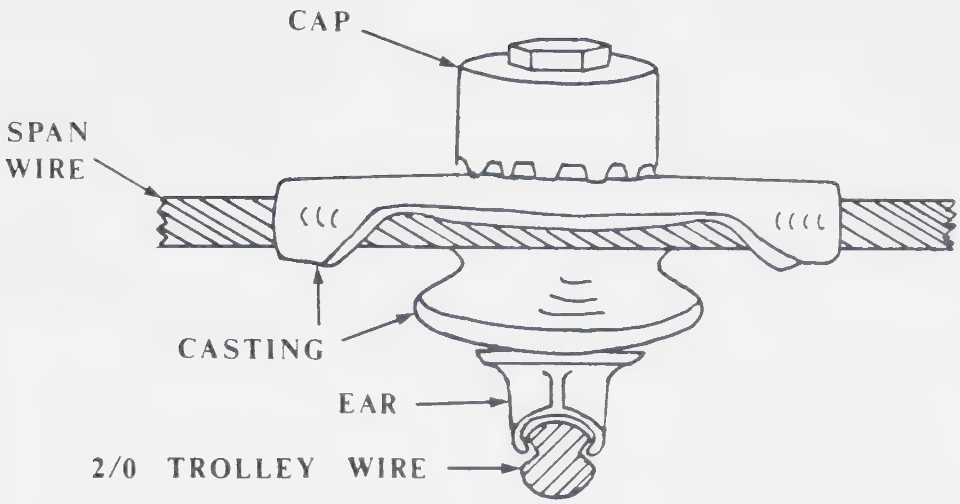


FIGURE 23. 1908 STYLE OF HANGER, EAR AND WIRE

Overhead construction on curves caused a problem. The problem was how to get the trolley wire to follow a smooth curve. A special span-wire arrangement was installed. Four poles were placed so that when span wires were strung between each one, a square was formed over the area of the curve. Varying lengths of span wire were attached to these border span wires. The shorter span wires were connected to special hangers called "curve hangers". Curve hangers were similar in appearance to straight hangers except that curve hangers had one or two large eye lugs (depending upon whether there was one or two tracks in the curve) that were designed to allow span wires to be attached to them. (Ohio Brass Company Catalog No. 23, 1940, p. 109) The curve hangers were attached to the trolley wire by plain ears. When the installation was complete, the trolley wire would conform to the shape of the curve because of varying lengths of span wire attached to the curve hangers. As an added precaution against electrical problems, the span wires attached to the curve hangers were insulated from the border span

wires on the poles by means of wooden strain insulators. (Doane & Parkham, 1926, § 18 p. 19) A wooden strain insulator consisted of a short length of linseed oil impregnated hickory dowel with galvanized malleable iron castings swaged onto each end. The castings had eye lugs or clevis arrangements that allowed span wires to be fastened to them. Wooden strain insulators were designed to withstand tensile strains of at least 7,000 pounds (3 175 kg). (Westinghouse Catalog of Trolley Line Materials, 1932, p. 38) Figure 24 (after Doane & Parkham, 1926, § 18 p. 19) shows the plan view of a typical overhead layout for a double-track curve. The placement of the span wires and the strain insulators should be noted.

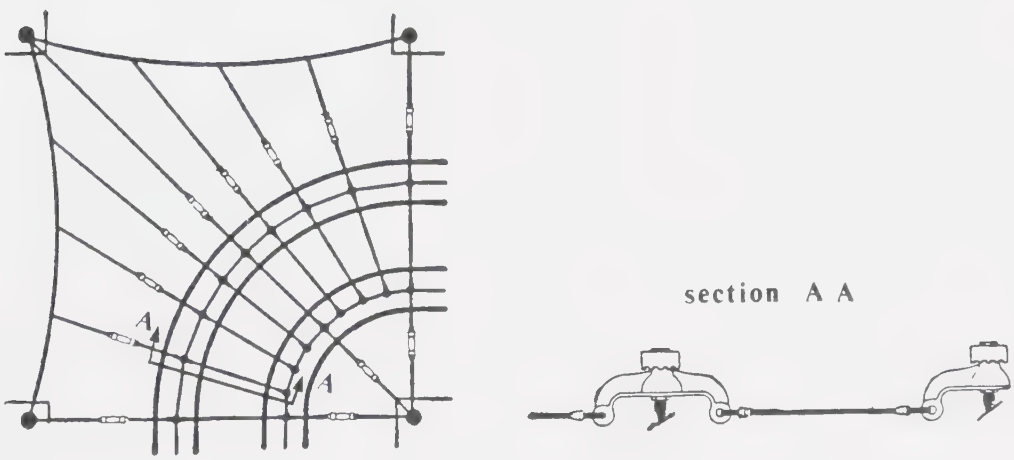


FIGURE 24. TYPICAL CURVE LAYOUT

A special item of overhead equipment was required when a switch was encountered on a street railroad track. At a switch, a streetcar had the option of proceeding straight or turning onto the diverging or

converging track of the switch. In order for the trolley wheel (current collector) to remain on the wire, an overhead frog had to be installed that allowed the trolley wheel to follow one of the two possible wire paths. Overhead frogs, which were usually formed from phosphor bronze, consisted of a shallow trough called a pan that allowed three trolley wires to be connected to it by the use of special ears that fitted into hooks cast into the frog. There were also three small tapered runners in the pan that guided the trolley wheel to and from each wire. The operation of an overhead frog was simple. It was located several feet (mm) beyond the start of the switch tongues. If, for example, a streetcar began to travel onto the diverging track, the streetcar and its trolley wheel would begin to angle away from the trolley wire leading to the switch. When the trolley wheel reached the frog and the end of the wire it had been on, the twisting motion in the trolley wheel was sufficient so that it slid to the side of the pan. As the streetcar continued, the tapered runner leading to the diverging track's trolley wire would guide the trolley wheel into place on that wire. In this manner, the trolley wheel was moved from one wire to another. (Ohio Brass Catalog No. 23, 1940, pp. 120-121) Figure 25 (after Ohio Brass Catalog, p. 121) depicts the underside view of a typical overhead frog.

When two trolley wires crossed, in a three-part Y for example, another piece of overhead material was required, an overhead crossing. The operation of an overhead crossing was similar to that of an overhead frog. The overhead crossing, however, had provisions for four trolley wires and the angle of the crossing could usually be adjusted. In addition, the tapered runners were aligned so that the trolley wheel did not move to the side. It should be noted that if a streetcar travelled past a piece of overhead special work at too great a speed, the effects of inertia

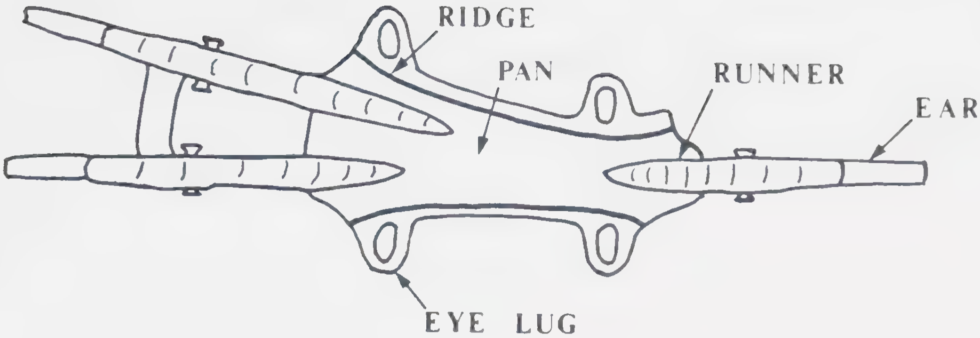


FIGURE 25. UNDERSIDE OF 15° FIXED FROG

and centrifugal force would cause the trolley wheel to dewire, cutting power to the streetcar and, possibly, causing damage either to the overhead or to the trolley pole.

It was, on occasion, necessary for two trolley wires to be spliced. It was imperative, in making that splice, that the smoothness and the electrical conductivity of the wire be maintained. To accomplish this, special phosphor bronze splicers were used to join the wires. A splicer consisted of a casting that resembled an ear. The ends of the two trolley wires were first slid into machined grooves in the splicer. The edges of the splicer were then clinched to the wires using a clinch block. This arrangement provided a strong and a smooth splice. (Ohio Brass Catalog No. 23, 1940, p. 106)

Between 1908 and the end of 1910, all of the distribution materials and construction methods heretofore described were used on the ERR. The steel centre-pole construction was primarily used on the main, heavily travelled portions of the system (Jasper Avenue for example). Wood

centre-pole construction was frequently used on main streets that had not been paved, Whyte (82nd) Avenue in Strathcona for instance. Span-wire construction was generally used on curves or on streets that were too narrow for centre-pole construction. Side-bracket construction, which used the smallest number of poles, was generally installed on infrequently used lines such as turnouts or temporary track extensions. (ERR Drawings Showing Position of Poles, 1908, 1911, and Doane & Parkham, 1926, § 18 pp. 15-20)

Mechanical Production, 1911-1912

In April 1911, the ERR ordered a 500 kW synchronous motor generator from the Canadian Westinghouse Company with the intention of placing the unit in a temporary substation located near the streetcar barns on Syndicate Avenue (95th Street). (Letter from the City Secretary-Treasurer to the City Commissioners, April 6, 1911, and SRDGL, Account C20) The operation of a synchronous motor generator, while similar to the basic operation of a plain motor generator, was more complex since a synchronous motor generator was designed to regulate its output automatically without constant supervision. The commutator and the field windings of the generator were interconnected with coils located on the motor's rotor in such a way that, as the speed of the motor increased, the D.C. generated by the generator would regulate the voltage reaching the motor's rotor field windings. In normal operation, the speed of the motor generator was such that the output of the generator remained at 550 volts D.C. If, for example, the load on the generator increased so that its speed was reduced, the resulting drop in output voltage reaching the motor's rotor field windings would enable the motor to increase speed until 550 volts was produced by the generator, at which

point the speed of the motor would stabilize. (A.C. Machines, Transformers, Rectifiers, 1941, pp. 65-70, and Dover, 1929, pp. 647-649) In this manner, a synchronous motor generator automatically maintained a steady D.C. output voltage. The Westinghouse unit that was purchased was well suited for economical substation work. Its 700 H.P. (522.2 kW) motor required three-phase A.C. at 2,300 volts which could be transmitted at a higher voltage to the substation resulting in minimal line loss. (Report to the City Commissioners from Power Superintendent Cunningham, November 22, 1928, p. 2, and CEAR, 1913, p. 269) The ERR constructed a small wooden frame building immediately south of Syndicate Avenue (95th Street) streetcar barns to house the synchronous motor generator. (SRDGL, Accounts C20 & C20A, 1911) Initially, three feeders originated at the substation. One travelled south along Syndicate and was connected to the trolley wire at Sutherland Street (106th Avenue). The next feeder travelled east where it connected with trolley wires at two locations, Kinnaird (82nd) Street and Agnes (79th) Street. The final feeder travelled north and then east paralleling the tracks on Kirkness (95th) Street and Alberta (118th) Avenue as far as Douglas (78th) Street. This feeder connected with the trolley wire a total of seven times. The distance between the feeder taps on this particular feeder was approximately 580 feet (176.8 m) or at every fifth support pole. (ERR Drawing Showing Feeder Lines, 1912, see Map 6 for the location of the tracks) The extensive use of feeder taps on the one feeder was intended to keep line loss to a minimum when those sections of track were in heavy use. (Dover, 1929, pp. 621-624) While the temporary substation provided some additional power to ERR tracks outside the radius of the power plant, the addition of more rolling stock coupled with the construction of new lines made the installation of more feeders and generating equipment

imperative.

The perennial problems of power shortages continued to bedevil the ERR. In the 1911 Annual Report, ERR Superintendent R. Knight stated, "Spare [generating] capacity is also necessary, so that breakdowns in the generating plant will not cuase derangement of traffic and schedules such as have been experienced in the past, with their resultant financial loss to this Department" (p. 150). The late arrival of some needed A.C. equipment plus frequent failures of the gas producer plant and engine were factors in the continued power shortages experienced by the ERR. (CEAR, 1911, pp. 126-127) In addition, the old Robb steam engine connected to the 300 kW Westinghouse generator was unable to provide maximum power without overheating. On several occasions when streetcar traffic was heavy, the engine had to be shut down in order to prevent the catastrophic failure of its moving parts. When the engine was shut down, however, the power available to the ERR was reduced so that streetcar operation slowed or stopped, depending upon the output of the other generating equipment. (Edmonton Capital, November 27, 1911, p. 10) It was apparent that this arrangement could not continue.

In January 1912, the Robb engine was disconnected from the Westinghouse generator. The engine was later sold. (Edmonton Capital, January 22, 1912) The Power Plant Department decided to couple the generator (which was now considered small compared to the capacity of the synchronous motor generator) to an A.C. motor, thus producing a motor generator. (CEAR, 1912, p. 196) A 425 H.P. (317 kW) motor was ordered from the British branch of the Siemens Company of Germany. The motor did not arrive until early 1913. (CEAR, 1912, p. 196, 1913, p. 268) The ERR faced a protracted power shortage until the loss of the 300 kW generator could be compensated for in some way. In March, the ERR

invited tenders for another 500 kW synchronous motor generator. (Edmonton Capital, March 16, 1912) The contract was awarded to the Canadian Westinghouse Company and when the unit arrived, it was temporarily installed in the power plant. (CEAR, 1913, p. 207) This synchronous motor generator had been purchased for a new ERR substation but the construction of the building to house this piece of equipment had not been started. By locating the unit at the power plant, the power shortage caused by the temporary loss of the 300 kW generator was alleviated.

By the end of 1912, the ERR possessed a total of 50 streetcars, both passenger and freight. (See Appendix I) The ERR had also ordered an additional 35 passenger streetcars for delivery during 1913. (Preston Car and Coach Company Contract for Streetcars, November 5, 1912) Additional generating equipment had to be obtained if the ERR was going to be able to operate the new rolling stock. Since most of the heavy streetcar traffic was located within the radius of the power plant, the Power Plant Department decided to increase its D.C. capacity. In order to accomplish this, an order was placed for one 1,000 H.P. (746 kW) Belliss and Morcom triple expansion steam engine. (PDAR, 1927) This engine was to be connected to a 750 kW, 575 volt D.C. Siemens generator that was also ordered at the same time. (CEAR, 1912, p. 196) The engine and the generator were both manufactured in England. English products were purchased because the trade tariffs of the time meant that British goods could be imported at a lesser cost than American goods. In addition, the two major North American manufacturers of heavy D.C. generating equipment, General Electric and Westinghouse, had raised their prices so that they could not compete with British made equipment. (Report to the City Commissioners from Power Superintendent Cunningham, February 7, 1928)

Power Distribution, 1911-1912

The power shortages experienced by the ERR had been thought to be the result of insufficient generating capacity. By the end of 1910, however, the Superintendent of the ERR, C. V. Biswanger, believed that the power shortages were partially caused by excessive loss in the rails. (CEAR, 1910, p. 111) It should be remembered that initial track construction did not include the use of rail bonds (bonds between rail sections at the joints). Biswanger felt that if the ERR was to overcome its power supply problems, an attempt should be made to make the distribution system more efficient. It was recommended, therefore, that all rail joints be bonded and that a negative feeder be installed. (CEAR, pp. 111-112) The installation of rail bonds in completed track did take place but at a slow rate. (CEAR, 1912, p. 207) The type of rail bond used consisted of a 10 inch (254 mm) length of heavy braided copper wire which had a large lug crimped to each end of the wire. The bond was welded to the outer side (the side where no wheel flanges would pass) of each rail head. The bond was placed so that there was considerable slack in the copper wire. This slack allowed for the expansion and contraction of the joint. (ERR Drawing of Proposed Track Construction, Type No. 1, December 1912) Plate 10 (Provincial Archives of Alberta) shows several rail bonds in place on the grand union under construction at 109th Street and Jasper Avenue. Although the photograph was taken during 1913, it illustrates the type of rail bond that was widely used on the ERR. Throughout 1912, all new track construction incorporated rail and cross bonds. (CEAR, 1912, p. 207, and Glenbow Archives Photograph NC-6-64604)

In addition to improvements to track bonding, the ERR endeavoured

to improve the condition of the overhead trolley wire. The system of wire suspension that was used by the ERR (described in a previous section) held the trolley wire rigidly to the span wires. As the seasons changed and the ambient temperature fluctuated, the trolley wire attempted to expand and contract. Since the suspension did not allow for much movement, it was not uncommon for the trolley wire to stretch or to sag, causing the streetcars' trolley wheels to dewire frequently. (Doane & Parkham, 1926, § 18 pp. 20-21) In order to minimize the effects of temperature on the trolley wire, frequent maintenance of the suspension had to take place. To facilitate maintenance, a device was needed that enabled line crews to work on affected areas of the overhead, while at the same time allowing streetcars to pass.

In January 1910, ERR Superintendent Taylor received approval from the City Commissioners to purchase a horse-drawn tower wagon. (Letter to ERR Superintendent Taylor from the City Commissioners, January 3, 1910) The tower wagon, which was manufactured in Canada by the Ottawa Car Company under license from the Trenton (New Jersey) Wagon Company, consisted of a four-wheeled, two-horse wagon on which was mounted a telescoping wooden tower. The wagon could travel on the streets without the use of streetcar tracks. The tower, which could be raised and lowered by a steel cable winch mechanism, had a revolving platform on the top that was moved by a crank operated by the person standing on the platform. (Letter to the City Commissioners from ERR Superintendent Taylor, January 3, 1910, and Electric Service Supplies Co., Catalog 4, 1911, p. 544) According to Taylor, the main advantage of such a wagon was, "the man on the tower can set his waggon clear of the track, turning the platform in and out from his work every time a car [streetcar] passed". (Letter to the City Commissioners, January

3, 1910) Plate 13 (Provincial Archives of Alberta) shows the tower wagon in use sometime during 1912. Dewirements continued to be a prevalent problem in spite of increased maintenance of the overhead. In one unfortunate instance in December 1911, a streetcar's trolley wheel dewired at night while the streetcar was on the turning loop adjacent to the Swift packing plant (see Map 6 for location). Another streetcar, which had been a short distance behind, failed to see the darkened streetcar because there were no street lights at that location. The second streetcar rammed the first, injuring one of the passengers in the darkened streetcar. The result of the accident was a law suit against the City by the passenger. In an attempt to prevent a repetition of that sort of accident, the City Commissioners ordered that all streetcars were to carry a lighted kerosene lantern with a red glass on the outside of each end. (Edmonton Journal, December 29, 1911, p. 1) It was thought that the red light would be seen if the streetcar was plunged into darkness for any reason. The lanterns were purchased from a local supplier early in 1912. (SRDGL, Account T13, March 12, 1912)

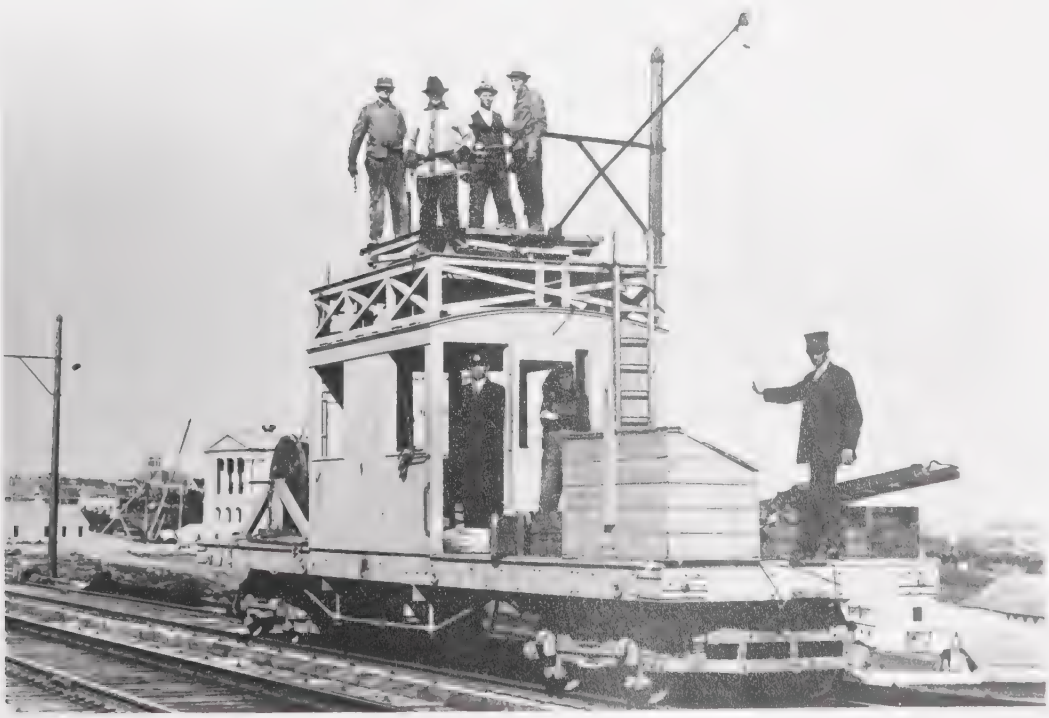
Plans for extensive track extensions had been approved by the City Council during 1912. The ERR, not wishing to experience a continuation of the power distribution problems of the past, submitted complete details of the approved extensions as well as details about the present operation to a board of engineers in Montreal. (CEAR, 1912, p. 207) The ERR management hoped that the board of engineers could devise a suitable and efficient power distribution system for the ERR. (CEAR, p. 207)

Mechanical Generation, 1913-1926

The generating equipment that had been ordered by the Power House Department in 1912 arrived in early 1913 and was placed in operation.

Plate 13. (Provincial Archives of Alberta) Tower Wagon, 1910

Plate 15. (Provincial Archives of Alberta) Line Car L-1, 1913



The Westinghouse 300 kW generator was once again made operable with the installation of the 425 H.P. (317 kW) Siemens motor. The new 750 kW Siemens generator was also placed in operation. (CEAR, 1913, p. 268) That unit was driven by a Belliss and Morcom triple expansion steam engine. This particular type of engine consisted of three vertical cylinders, each of progressively larger size. The operation of the engine was similar to the operation of a compound engine except that the steam passed through an additional cylinder before being recycled. (PDAR, 1927) Plate 14 (Glenbow Archives) shows the Siemens generator and the Belliss and Morcom triple expansion steam engine in operation at some time during 1913. The man standing on the steam engine provides an idea of the size of the equipment. Directly behind the Siemens generator can be seen the Crocker-Wheeler generators.

In May 1913, the City Commissioners decided that all street railway power generating equipment was to be operated by the Power House Department. The two synchronous motor generators purchased by the ERR were transferred to the Power House Department. (CEAR, 1913, p. 269) A permanent street railway substation was being constructed immediately south of the ERR's new Cromdale streetcar barns (see Map 8 for location. The substation was completed in November 1913 and the 500 kW synchronous motor generator, formerly located at the power plant, was placed in operation there. In early 1914, the temporary substation on Syndicate Avenue (95th Street) was abandoned and its 500 kW synchronous motor generator was also installed in the new substation. In addition, the 250 kW Canadian General Electric motor generator purchased in 1908 was also installed in the substation. (CEAR, p. 269, and Report to the City Commissioners from Power Superintendent Cunningham, November 22, 1928) In order to power the synchronous motor generators,

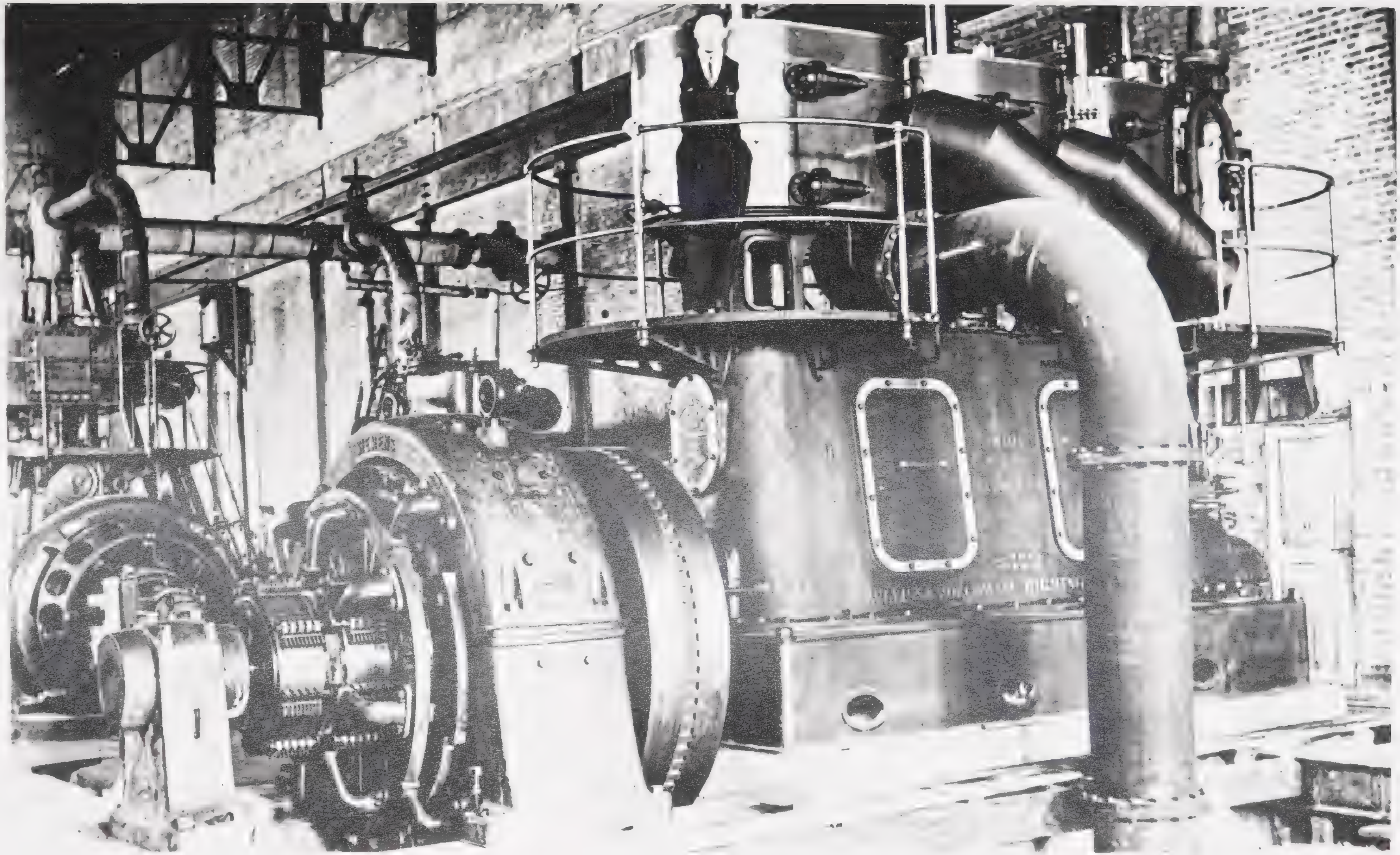


Plate 14. (Glenbow Archives) Engines and Generators at Power Plant, 1913

a high voltage A.C. line was erected between the power plant and the substation. Through the use of step-up transformers, the required 2,300 volts was transmitted to the substation at a value of 6,600 volts, which was thought to be the most economical transmission voltage (least line loss). Once at the substation, two step-down transformers provided the synchronous motor generators with 2,300 volts A.C. (CEAR, 1913, p. 269)

In 1914, the Power House Department replaced the 550 H.P. (410 kW) Robb steam engine which powered one of the Crocker-Wheeler generators with a 550 H.P. (410 kW) Belliss and Morcom steam engine. (CEAR, p. 273, and PDAR, 1927) The Robb engine was replaced because it was not compatible with the new Belliss and Morcom steam condenser. (CEAR, 1913, p. 273) At the end of 1914, based on the information cited in this chapter, the total D.C. capacity available to the ERR was 3.2 MW. This capacity was sufficient to meet the needs of the ERR until 1927 when destructive equipment failures began to diminish the total generating capacity. (PDAR, 1927, p. 7)

Power Distribution, 1913-1938

The track construction program undertaken by the ERR in 1913 more than doubled the extent of operable track. (CEAR, 1913, p. 287) As the new track was being built, a new electrical distribution system was installed. This new system, partially designed by the Montreal board of engineers, consisted of an extensive network of positive and negative feeders as well as the increased use of segmented steel poles for the three types of trolley wire suspension used in Edmonton. (CEAR, p. 288) The negative feeder system that was introduced consisted of large insulated copper cables approximately ½ inch (12.7 mm) in diameter that

ran underground between the power plant or the Cromdale substation to points near special track work. At those points, the feeders entered special rectangular cast iron cabinets called "feeder pillars". The feeders entered the part of the pillar that was placed underground. The part of the pillar that was above ground contained: an ammeter that measured the amount of current entering the large feeder to the power plant from the smaller track feeders; terminal bars that enabled the track feeders to be connected to the large power plant feeder; and several switches which were used to isolate sections of track from the power plant feeder when repair crews were at work on the track. (ERR Drawing of Terminal Pillars for Negative Feeders, February 1914) Two copper earthing (grounding) plates, spaced 20 feet (6.1 m) apart, were located near each pillar and were connected by feeder cables to it. The copper earthing plates measured 3 feet (0.9 m) long by 2 feet 3 inches (0.7 m) wide and were 1/8 inch (3.8 mm) thick. The purpose of the earthing plates was to collect any current that had left the rails and was travelling through the ground. (ERR Drawing of Copper Earth Plates, February 1914) It should be noted that the negative feeder cables to the rails and to the earthing plates consisted of number 4/0 Brown and Sharpe gauge copper wire which was covered by insulation. Feeder pillars and their earthing plates were usually located near special track work because there usually was greater leakage of current to the ground at these points rather than on straight sections of track. (ERR Drawings of Negative Feeders for Special Work, 1913) In Plate 10 (Provincial Archives of Alberta) one can observe several of the insulated track feeder cables leading from the grand union. It seems that the system of negative feeder cables and feeder pillars that was used on the ERR was a system that had originated in Britain and was in common use there. (Dover, 1929, pp.

624-628) Individual feeder pillars were located at various distances from the power plant or substation. To ensure that one large feeder did not draw more current than another thereby causing electrolysis to occur, line loss calculations were made and resistors were installed on feeders that were considered to be short enough to have an effect on the current flow of other feeders leading to the power plant or substation. This action was considered to be temporary as it made the feeder system inefficient. The ERR's future plans called for the installation of voltage boosters on the long power plant and substation feeders. (ERR Plan of Negative Feeder System, December 1913) A booster was a special type of motor generator. The field windings of the generator portion were connected in series with its armature so that the output voltage of the booster would increase and decrease in proportion to increases and decreases in feeder voltage. The purpose of a booster, therefore, was to add its voltage to the feeder in order to maintain the feeder voltage at 550 volts. (Doane & Parkham, 1926, § 17 pp. 11-17) Boosters were expensive items so the City Commissioners decided to postpone the purchase of any boosters until it could be determined that they were essential. Although the negative feeder system functioned to some extent without boosters, the system did not function efficiently. This inefficiency enabled some return current to travel through the ground.

In January 1915, ERR Superintendent J. Larmonth informed the City Commissioners that electrolytic destruction of water pipes would continue to be a serious problem until the required boosters were installed. (CECR, January 5, 1915) The boosters were not purchased, however. There appears to have been two reasons for this. By the beginning of 1915, Edmonton was in the midst of a serious financial recession and the purchase of expensive and non-essential equipment was not considered

to be a priority. In addition, the ridership and the traffic on the ERR fell drastically after the start of the First World War. In view of the decreased traffic, many City officials felt that the boosters were superfluous. (CECR No. 195, September 5, 1916)

The positive distribution system also underwent considerable revision during the 1913 construction. On most paved or heavily used streets the ERR and the Electric Light and Power Department installed steel poles to support the overhead wire. (CEAR, 1913, p. 288) Heavier steel poles were installed at locations where there would be greater tension on the poles. These locations included curves and special work. (ERR Drawing of Standard Wrought Iron Tubular Poles, February 1913) A new method of installing trolley wire was also adopted in 1913. Prior to this time, the wire had been strung dead along the span wires. Hangers and ears were then installed and, finally, the trolley wire was tensioned and attached to the ears (see previous section, Power Distribution, 1908-1910). In order to speed the installation of trolley wires, the ERR began to erect live trolley wires. In this method, one end of a reel of trolley wire was spliced to an existing trolley wire that was in use. The reel was mounted on a push cart in such a way that it could be unwound under tension. A line work car or a passenger streetcar with a platform on the roof would be used to propel the cart forward. As the streetcar moved forward, the trolley wire would rise and pass over the roof. When span wires were encountered, the streetcar motorman would be signalled to stop and the men on the platform would affix the trolley wire to the span wire with hangers and ears. (Doane & Parkham, 1926, § 18 p. 18) The span wire was usually insulated from the ground by the use of wooden (usually hickory) or porcelain strain insulators. It was necessary to insulate the span wires from the poles in order to prevent the line

crews from becoming accidentally grounded, thus electrocuting themselves. In addition, wherever steel poles were used, span wire insulation ensured the safety of pedestrians should a hanger insulator fail and the span wire became energized. The ERR temporarily fitted passenger streetcar number 7 with a platform so that it could be used to install live trolley wire. Plate 9 (Glenbow Archives) shows passenger car number 7 in use as a line car during 1913. The reel of trolley wire and the platform on the streetcar's roof should be noted. The ERR also constructed a work car that was specifically designed for line construction. (CEAR, 1913, p. 288) Plate 15 (Provincial Archives of Alberta) shows the line car on the High Level Bridge during 1913. The location of the trolley wire wheel on the car as well as the hangers and ears on the platform should be noted. More information about the line car can be found in a subsequent chapter.

A new type of hanger was introduced in 1913. The previously used hangers consisted of a stud or bolt that was surrounded by insulating material. This assembly was held in a galvanized malleable iron casting. (See previous section, Power Distribution, 1908-1910) The new hanger that was used consisted of a small, one-piece galvanized malleable iron casting. The stud, for connecting the ear to the hanger, was implanted in insulating material that was molded directly into the casting. (Artifacts in the Author's Collection, and Canadian Ohio Brass Catalog No. 23, 1940, p. 91) The new type of hanger was smaller and was considered not to be as susceptible to insulation failure than the earlier types in use. Figure 26 (after Canadian Ohio Brass Catalog No. 23, 1940, pp. 90-91) shows the appearance of the hanger used from 1913. A new item of overhead special work was installed by the ERR during this period. The Board of Railway Commissioners (BRC), who were responsible for

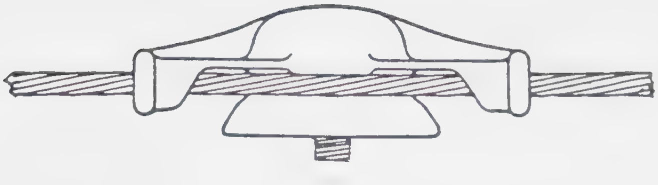


FIGURE 26. ROUND-TOP HANGER

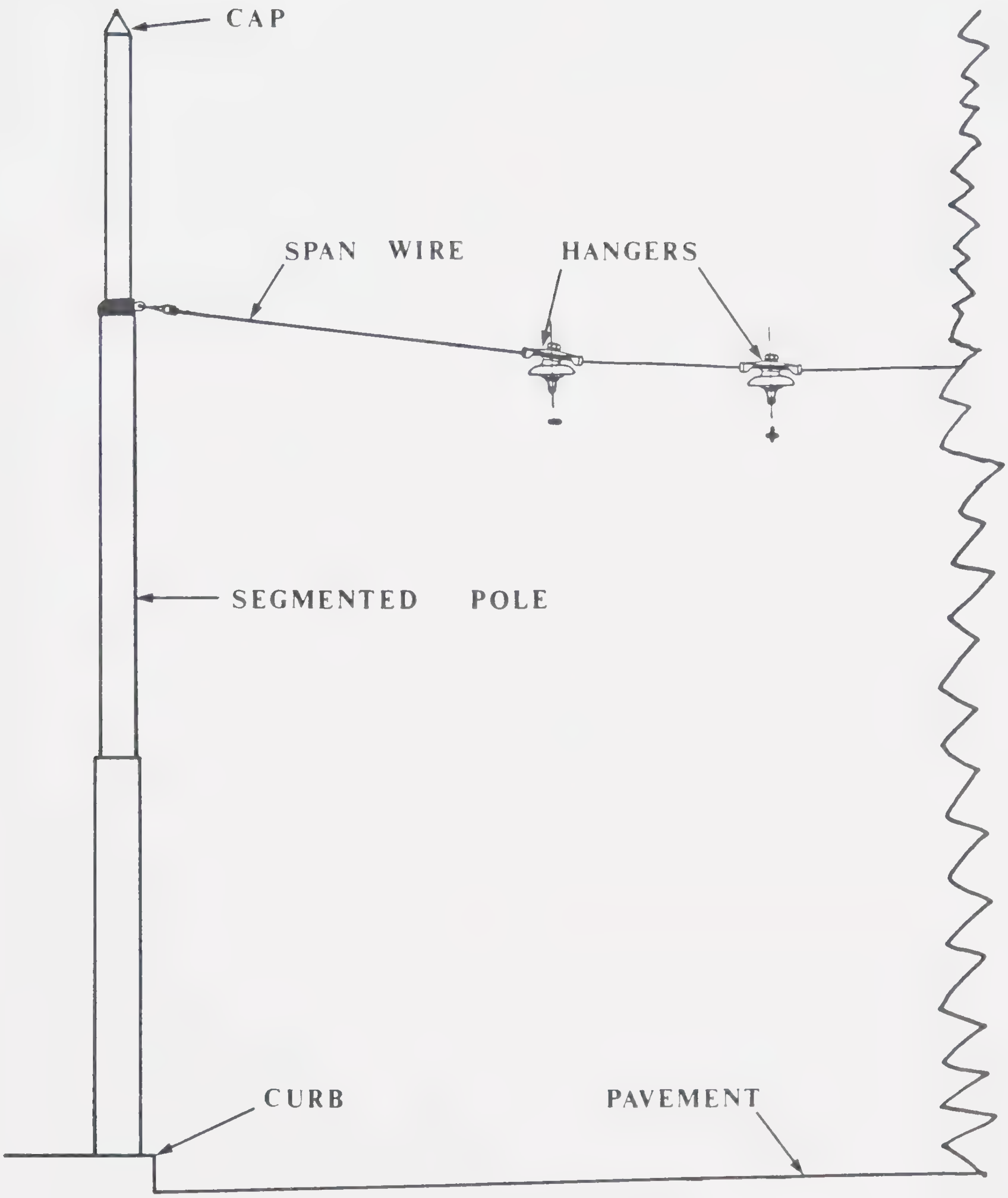


FIGURE 27. AN APPLICATION OF SWIVEL-TOP HANGERS

the safety of any rairoad that crossed a chartered steam railroad, ordered the ERR in 1913 to install "National trolley guard" on their lines that crossed frequently used steam railway tracks. (CECR No. 211, October 1, 1915, p. 2) National trolley guard was the patent name of a safety feature which was intended to prevent streetcars from losing electrical power as they crossed a steam railroad track. The trolley guard consisted of galvanized steel wire mesh that was fastened in a semicircular fashion around the top of the trolley wire. The wire was galvanized to prevent the formation of iron oxide (rust). Strain insulators isolated the trolley guard from the poles. The trolley guard began a few yards (metres) before a crossing, covered the entire length of the crossing, and ended several feet (metres) after the crossing. (Electric Service Supplies Co. Catalog No. 4, 1910, p. 260) The purpose of the trolley guard was to prevent a dewirement from stopping a streetcar in the vicinity of a railroad crossing. For example, if a streetcar was crossing a set of tracks and its trolley wheel left the wire, the streetcar would continue to receive power because the trolley wheel would be in contact with the galvanized mesh which was energized by the trolley wire. Once the streetcar had cleared the crossing, the motorman or conductor could stop the streetcar and could replace the trolley wheel on the wire. (Electric Service Supplies Co. Catalog No. 4, 1910, p. 258)

The positive feeder system was also upgraded beginning in 1913. In previous years, the ERR had used very few feeders. The lines that were served by feeders rarely had more than three widely-spaced feeder taps. (ERR Drawing Showing Feeder Lines, 1912) The new feeder system called for positive feeders to parallel each line, and for feeder taps to be placed either at every third pole on heavily-used lines such as Jasper Avenue, or at every fifth pole on other lines. The feeder cables were

to be Brown and Sharpe number 4/0 gauge insulated copper. Besides an increase in the number of feeders and feeder tapes, the trolley wire was to be divided into electrically separable sections ranging in length from 1 to 3 miles (1.6 to 4.8 km). (Drawing of Proposed Scheme of Positive and Negative Feeders, 1913) The purpose of dividing the wire into sections was to enable the rest of the system to function if one section should develop a short circuit or a particular section required extensive repairs. By means of switches and section insulators, the affected section of trolley wire and its feeders could be isolated from the remainder of the system. In normal operation, however, all sections were connected so that a short circuit could (depending upon the number of streetcars in service at that time) either cause the circuit breaker to open or allow the area of the short circuit to heat and possibly melt the trolley wire. (Doane & Parkham, 1926, § 18 pp. 7-10) A section insulator consisted of a length, usually about 10 inches (254 mm), of 4 inch (107 mm) high, treated hickory with clamps on each end to hold trolley wire. The hickory beam was shaped so that it matched the width of the trolley wire. (Canadian Ohio Brass Catalog No. 23, 1940, p. 114) To install a section insulator in existing wire, a small piece of the wire was cut out of the existing overhead. The ends of the wires were then secured to the section insulator clamps. In new construction, the section insulators were installed as the trolley wire was being strung. The fittings on the section insulators allowed jumper cables or switch cables to be attached so that individual sections of the trolley wire could be connected together. (Canadian Ohio Brass Catalog No. 23, 1940, pp. 114-116) Later versions of the section insulators for this period had renewable reinforced rubber runners that were replaced as they wore out. Renewable runners tended to prolong the life of the wooden section insulators. (Canadian Ohio Brass Catalog

No. 23, 1940, p. 116)

By 1917, much of the original hard-drawn copper trolley wire had worn to such an extent that it required immediate replacement. (CECR No. 120, June 19, 1917) The ERR replaced several miles (km) of trolley wire during 1917 and 1918 with new hard-drawn copper wire of the same size. (CECR No. 71, May 28, 1917) The ERR was beginning to realize that hard-drawn copper trolley wire, while possessing good conductivity, did not have substantial wear resistance so the life of hard-drawn copper trolley wire on the ERR was approximately 10 years.

By 1925, the ERR was replacing worn trolley wire with a copper and cadmium alloy wire, sometimes referred to as "bronze trolley wire". (SRDAR, 1925, p. 6, and Letter to the City Commissioners from ERR Superintendent T. Ferrier, December 23, 1938) Cadmium was added to the copper in order to increase the wear resistance of the wire. (Doane & Parkham, 1926, § 18 pp. 13-14) Although the percentage of cadmium to copper was not specified in the 1925 Annual Report, it seems likely that the wire was composed of 65% copper and 35% cadmium since subsequent orders specified this type of standard alloy trolley wire. (Letter to the City Commissioners from ERR Superintendent T. Ferrier, December 23, 1938, and Modernizing Overhead for the Trolley Coach, 1937, p. 64) The type of copper and cadmium trolley wire that was used did not conduct electricity as well as hard-drawn copper trolley wire. It was believed that the alloy trolley wire would last much longer than plain copper wire, thus reducing maintenance and replacement costs. (Canadian Ohio Brass Catalog No. 23, 1940, p. 203)

The tower wagon that had been purchased in 1910 was considered obsolete by 1923. In order to use the wagon, the ERR had to ensure that two horses were kept available. Horses, unlike machines, required

both constant feeding and heated shelter in winter weather. The upkeep of horses was costly to the ERR. In most instances, the line car could be used to undertake the necessary maintenance work on the overhead. The tower wagon, therefore, was rarely used. In April 1923, the ERR sold the tower wagon. The tower assembly was retained, however, and was later fitted onto a motor truck. (SRDGL, Account C11, April 1923)

Mechanical Generation, 1927-1951

By 1924, traffic had increased on the ERR so that the capacity of the D.C. generating equipment was being exceeded by 25%. (PDAR, 1924, p. 3) The Superintendent of the Power House, W. J. Cunningham, warned that this situation could not be continued in the future, "while these machines have by careful operation and maintenance successfully carried overloads for long periods, a break down of any one of them would seriously curtail the Street Railway service" (PDAR, p. 3). The City Commissioners did not recommend the purchase of additional equipment so the overloading of the existing equipment continued. On February 20, 1927, the 1912 Belliss and Morcom steam engine that had been powering one of the 400 kW Crocker-Wheeler generators suffered the effects of a broken connecting rod while the engine was operating at full power. (Letter to the City Commissioners from Power Superintendent W. J. Cunningham, February 23, 1927) A connecting rod was a part that joined the piston to the crankshaft of an engine through pins. The result of the broken connecting rod was the destruction of the cylinder head of the engine. In addition, falling parts from the engine irreparably damaged the generator that was coupled to it. The cost of repairing both the engine and the generator was thought to be in excess of replacing them with new equipment. Additional generating capacity was required

at once since there was no reserve capacity. Superintendent Cunningham stated that developments in power generating technology had made reciprocating engines obsolete. Cunningham recommended the purchase of a mercury arc rectifier or a large motor generator as replacement for the destroyed equipment. (Letter to the City Commissioners from Power Superintendent W. J. Cunningham, February 23, 1927)

The power shortage on the ERR became critical on February 28, 1927 when the Siemens 750 kW generator developed a short circuit in its commutator and had to be taken out of service for several days. During that time, only half the normal service could be offered by the ERR. (Report to the City Commissioners from Power Superintendent W. J. Cunningham, March 5, 1927) In order to increase the D.C. capacity immediately, Cunningham asked for permission to purchase a used 750 kW synchronous motor generator from Calgary. The unit had been in service there since 1919 and was considered to be satisfactory for service in Edmonton. (Report to the City Commissioners from Power Superintendent W. J. Cunningham) City Council gave its approval to the purchase and the unit from Calgary was in service by April 6, 1927. (PDAR, 1927, p. 7) At this point, the total generating capacity available to the ERR was 3.65 MW. (CEAR, 1928, p. 14) Additional generating capacity was essential to prevent another generator failure from curtailing service on the ERR.

In 1928, a complete study was undertaken by Power Superintendent Cunningham of the D.C. generating system for the ERR. In his report, Cunningham stated that the existing equipment was obsolete and could no longer meet the demands of the ERR. He further stated that, "a further extension of equipment had been deliberately delayed with a view to obtaining, when necessary, the most modern apparatus to meet

the requirements" (Report to the City Commissioners from Power Superintendent W. J. Cunningham, November 22, 1928). Cunningham recommended the purchase of a mercury arc rectifier for the power plant. He also advised the construction of additional substations to supplement the existing substation adjacent to the Cromdale streetcar barns. (Report to the City Commissioners from Power Superintendent W. J. Cunningham, pp. 4-5) Cunningham believed that a mercury arc rectifier was superior to a motor generator because mercury arc rectifiers: did not require frequent maintenance; had greater D.C. production capacity; had fewer parts; were more efficient; and occupied less space than a motor generator of comparable capacity. (Report to the City Commissioners from Power Superintendent W. J. Cunningham, February 5, 1929) No mercury arc rectifiers were manufactured in Canada at that time so they had to be purchased abroad. The Company that had the most experience in the manufacture of mercury arc rectifiers was the Brown Boveri Company of Baden, Switzerland. In addition, Brown Boveri rectifiers had been selected by 18 other Canadian users of D.C. (Report to the City Commissioners from Power Superintendent W. J. Cunningham) Cunningham, therefore, recommended the purchase of one 1 325 kW mercury arc rectifier from the American office of the Brown Boveri Company. The City Council gave its approval to the purchase. The unit was installed at the power plant and was in operation by December 11, 1929 (PDAR, 1929, p. 8)

In subsequent years, as additional mercury arc rectifiers were purchased, many motor generators were withdrawn from service. In 1934, however, the Power Plant Department determined that the ERR lines in the northwestern area of Edmonton were suffering from low voltages at rush hours and during extremely cold weather. To alleviate this

problem, the 250 kW motor generator of 1908 which had been out of service was installed at an A.C. substation located at 129th Street and 107th Avenue. The motor generator was rewired so that it would act as a voltage booster. (The operation of voltage boosters was discussed in a previous section.) Arranged as a booster, the motor generator could be operated without constant supervision. (PDAR, 1934, p. 7) The continued use of mechanical generating equipment was temporary. By 1935, a sufficient number of mercury arc rectifiers were in service so that the generators driven by steam engines were used only for peak loads and for emergencies. (Minutes of Power Department Committee Meeting, May 2, 1935, pp. 11-15) Some mechanical units were retained and used until after the Second World War when additional mercury arc rectifiers were obtained. By 1951, enough rectifiers had been placed in service so that all remaining mechanical equipment could be removed from service and disposed of. (Report to the City Commissioners from Power Superintendent W. I. McFarland, January 25, 1951) The conversion from mechanical generation to electrical rectification was complete.

Electrical Rectification, 1929-1938

In the previous section, it was stated that a 1 325 kW mercury arc rectifier was purchased from the American branch of the Swiss Brown Boveri Company. Several advantages of such a unit over motor generators were also stated. The operation of a mercury arc rectifier was radically different from the operation of a mechanical D.C. generator. Most D.C. generators were powered either by some sort of prime mover (engine) or by an A.C. motor. Mercury arc rectifiers relied upon an A.C. power supply. The power required was 13 800 volts, three-phase A.C. at a frequency of 60 Hz. (Letter to J. L. MacGuigan from ETS Superintendent

D. L. MacDonald, August 17, 1965) In order for the rectifier to convert the A.C. to D.C., two additional components were required: a three-phase to twelve-phase auto transformer with an interphase transformer; and a single-phase auxiliary transformer. (Thompson, 1940, pp. 341-342) A Brown Boveri mercury arc rectifier consisted of a large metal cylinder called an arc chamber which was surrounded by a water jacket for cooling. A pool of mercury was placed at the bottom of the cylinder which had an electrode called the cathode attached to it. Several inches (mm) above the cathode, and insulated from it, was a cover plate that contained a number of polished iron rods called anodes. There were usually 6 or 12 main and 3 auxiliary anodes. The Brown Boveri rectifiers which were purchased contained 12 main anodes. The sides of the anodes were surrounded by sheet metal shields to protect them from the destructive ultraviolet radiation present when the rectifier was in operation. The joints where the anodes met the cover plate and where the cover plate was attached to the cylinder were sealed with mercury. The air in the arc chamber was evacuated by means of a centrifugal pump since a high vacuum was required if the rectifier was to operate properly. The vacuum was maintained by the pump. (Dover, 1929, pp. 648-657) The rectifier operated on the principle that a high vacuum area containing a vaporized conductor, in this case mercury, would allow a current to flow from the anodes to the cathode in one direction only, thereby producing D.C. It was necessary to have several anodes and several phases of A.C. for the rectifier to operate efficiently since A.C. periodically dropped to zero and periodically changed polarity. It is for this reason that a three-phase to twelve-phase auto transformer was used. The A.C. entering the primary windings would be induced into four separate three-phase secondary windings that were joined at the neutral point through an inter-

phase transformer which was intended to stop D.C. from entering the secondary windings. While the primary windings could be arranged in either the delta or the Y (sometimes called star) connections, the secondary windings used the Y connection exclusively. Each secondary winding was connected to one main anode of the rectifier. Each set of secondary windings was 180° out of phase from the other. This meant that at least two anodes at a time would have the correct polarity to pass current to the cathode. (Dover, pp. 652-655) The operation of the rectifier depended, however, upon the presence of vaporized mercury in the arc chamber. The vaporized mercury was provided by an auxiliary system. A moveable ignition anode and two fixed excitation anodes were connected to a single-phase A.C. power supply, usually a transformer. To start the rectifier, an operator energized the auxiliary power supply. An electromagnet surrounding the shaft of the ignition anode forced it into the pool of mercury (cathode). As soon as the anode touched the mercury, the electromagnet circuit was interrupted and a spring pulled the ignition anode away from the mercury pool. An arc was then created. If the polarity of the arc was correct, the mercury was vaporized. If the arc possessed reverse polarity, an electromagnetic relay in the auxiliary circuit became energized and caused the electromagnet controlling the ignition anode to push it back into the mercury, thus extinguishing the arc. This process was repeated by the rectifier until an arc of the proper polarity was formed. Once the arc had vaporized enough mercury, the excitation anodes began to function and the arc was sustained. At that point, the three-phase to twelve-phase transformer was energized. Current could then flow from the main anodes to the cathode. The auxiliary system was left on in order to maintain an arc when there was little or no load on the main anodes. The D.C., at 575 volts, was collected

from the cathode, which was positive, and from the interphase transformer connected to the secondary windings, which was negative. The successful operation of the rectifier depended upon the repeated vaporization and condensing of the mercury. Since the rectification process also produced heat, the water jacket surrounding the arc chamber served not only to cool the rectifier but also served to condense the vaporized mercury. In addition, the anodes required some cooling. Metal cooling fins attached to the anodes and exposed to the surrounding air were considered sufficient for the anodes of Brown Boveri rectifiers. (Dover, pp. 649-659) Plate 16 (Edmonton Power Photograph) shows the original Brown Boveri rectifier as it appeared in 1981. The indicated parts of the unit should be noted.

In 1930, an additional Brown Boveri 1 325 kW rectifier and transformer was purchased and was installed at the substation south of the Cromdale street barns. (CECR No. 12, March 10, 1930)

Electrical Rectification, 1939

As early as November 1928, the Superintendent of the Power Department, W. J. Cunningham, called for the construction of additional D.C. substations for the ERR. Cunningham stated that additional substations had not been constructed in the past because they needed to be supervised by operators at all times and this was costly. It was also stated that substations equipped with mercury arc rectifiers did not need operators. (Report to the City Commissioners from Power Superintendent W. J. Cunningham, November 22, 1928) The economic depression of the 1930's stopped any plans for the construction of substations. Several outlying sections of the ERR suffered from extremely low voltages. The most notable area was the track to Calder north of 118th Avenue. That section was beyond the effective range of feeders from the power plant and

Plate 16. (Edmonton Power) 1929 Brown Boveri
Mercury Arc Rectifier in 1981

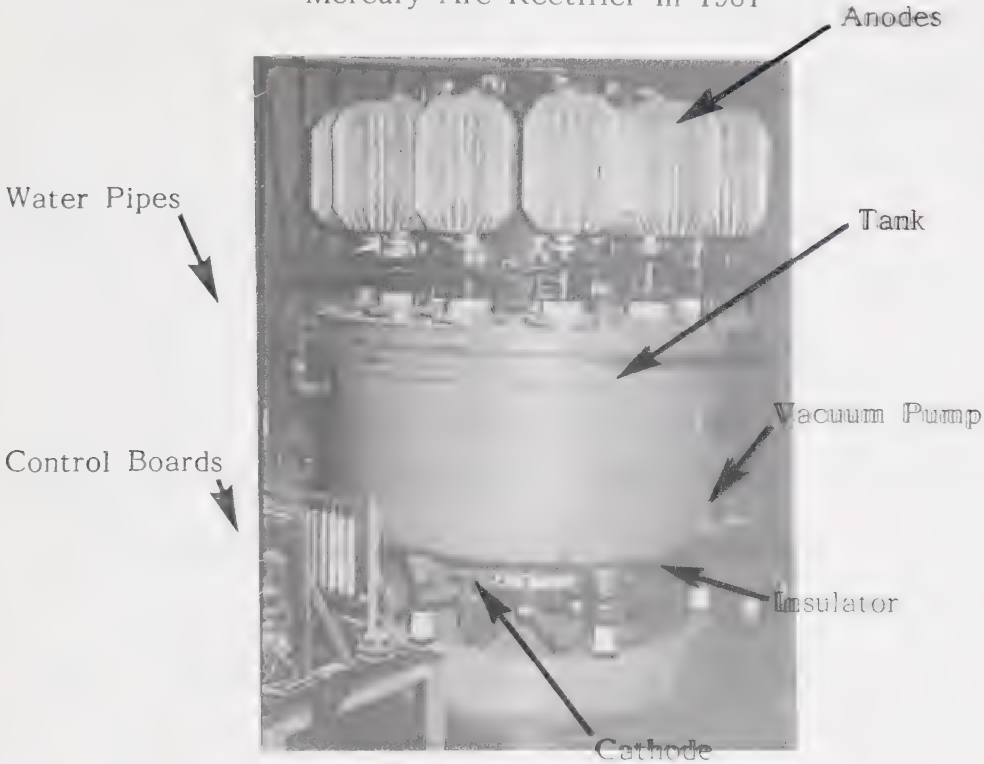


Plate 17. (City of Edmonton Archives) 1946 International
Truck with Wooden Tower during late 1940's

Plate 16. (Edmonton Power) 1929 Brown Boveri Mercury Arc Rectifier in 1981

Plate 17. (City of Edmonton Archives) 1946 International Truck with Wooden Tower during late 1940's

the Cromdale substation. It was mentioned in a previous section (Mechanical Generation, 1927-1951) that a motor generator had been installed as a voltage booster for that line in 1934. By 1937, however, the lack of a suitable feeder system on that line was causing serious problems with water pipes in the area. The Superintendent of the Electric Light and Power Department (EL&PD), W. Barnhouse, noted that many water pipes in the Calder area had been severely damaged by electrolysis. (Letter to ERR Superintendent T. Ferrier, November 27, 1937) The ERR was also contemplating the use of trolley buses so it appeared that additional D.C. capacity was required. (SRDAR, 1938) Based upon W. J. Cunningham's recommendations of 1928, a new D.C. substation was constructed on the southeast corner of 124th Street and 107th Avenue during 1938. The fully automatic substation was to contain a mercury arc rectifier. (CECR, January 11, 1939) Several improvements had been made to the design of mercury arc rectifiers since 1930. One serious disadvantage of the Brown Boveri rectifiers was that if a problem developed with an anode or with the vacuum pump, the entire unit had to be shut down until the necessary repairs had been made. In addition, Brown Boveri rectifiers required a water supply for the arc chamber water jacket. By 1938, the Hewittic Company, a British concern, had developed an air cooled rectifier that used several glass bulb assemblies instead of a single arc chamber.

The operation of a Hewittic rectifier was similar to that of the Brown Boveri rectifiers. In the Hewittic system, instead of one large arc chamber, several smaller glass bulbs were used. Each bulb consisted of a central portion that contained the mercury pool, the cathode and the auxiliary anodes. Radiating from the central portion were six tubular glass "arms", each with a main anode attached to the end. Each bulb

was a fully contained unit, and was sealed at the factory. No vacuum pump or mercury seals were required, therefore. (Hewittic Company Specifications, 1938) The entire rectifier unit consisted of several bulbs connected in parallel, the usual number was four, which gave the rectifier a 1000 kW capacity. Additional bulbs could be added to increase the unit's capacity. The advantage of the Hewittic system was that the rectifier could continue to function should one of the bulbs fail. Through a system of isolating links and switches, the affected bulb could be removed without shutting down the entire unit. The capacity of the rectifier would, however, be diminished. (Hewittic Company Specifications, 1938) The rectifier bulbs were enclosed in sheet steel cabinets. Each cabinet was connected to a ventilating fan which forced cool air over the bulbs, thus cooling them. The initial Hewittic rectifier installed at the new substation contained three bulbs and had a capacity of 700 kW. The main transformer was designed, however, to enable the unit's capacity to be increased to 1 000 kW with the addition of another bulb. (Hewittic Company Specification and Tender, 1938) The new substation was placed in operation in January 1939. (CECR, January 11, 1939) The problem of electrolysis and loss of power in the Calder area appeared to be eliminated by the new substation.

In a report to the City Commissioners, Power Plant Superintendent R. G. Watson stated,

> The operation of the rectifier has made it much easier for the cars to maintain schedules in the west end, as they have been able to accelerate faster. . . . The faster acceleration lightens the duty on the car motors and will, no doubt, show a lessening in maintenance of the motors. (February 6, 1939, p. 2)

The arrival of the Second World War was to put a stop to further installations of rectifiers until they could again be easily obtained from Britain.

Power Distribution, 1939-1946

In 1938, the ERR and the City Council decided to follow some of the recommendations of the Wilson and Bunnell Report (1938). This report called for the replacement of streetcars with trolley buses on certain routes of the system. (Wilson & Bunnell, 1938, pp. 1-2) Planning for the new trolley bus system had begun by October 1938. (SRDAR, 1938)

Electric trolley buses could not use a straight ground return system as the streetcars did. Trolley buses travelled on rubber tires and did not require any form of fixed roadbed. In order for a trolley bus motor to be connected to a D.C. circuit, therefore, the return portion of the circuit (the negative) was usually in the form of a second trolley wire suspended next to the positive wire. The negative wire was usually placed closest to the curb. To prevent the possibility of the two wires touching, they were placed a standard distance apart, 24 inches (610 mm). (Modernizing Overhead Construction for the Trolley Coach, 1937, pp. 1-26) Initial construction in Edmonton used 2/0 grooved alloy wire that consisted of 65% copper and 35% cadmium. (Letter to the City Commissioners from ERR Superintendent T. Ferrier, December 28, 1938) Although trolley bus wires were suspended in a similar fashion to streetcar wires, there were certain problems with trolley bus wires that required consideration. Fixed overhead frogs could not be used by trolley buses since they did not travel along a fixed roadbed. A system of moveable overhead switch points was, therefore, required. Whenever two sets of trolley wires crossed or converged, crossing positive and negative wires had to be insulated from one another to prevent short circuits. New types of steel and bakelite insulators replaced the previously used hickory section insulators.

In addition, most trolley buses did not use wheel current collectors but used current collectors made of steel or pressed carbon called "shoes". (Modernizing Overhead Construction for the Trolley Coach, 1937, pp. 5-7) The steel or carbon shoe was formed with a groove and like a trolley wheel ran on the underside of the wire. The groove enabled the shoe to remain in place on the wire. The shoe was held in a device called a "harp" which was connected to the trolley pole and which allowed the shoe to swivel so that the trolley bus could move laterally across the road without causing the current collectors to dewire. (Ohio Brass Publication K-336-R, pp. 1-6) The most common forms of trolley bus line suspension were the span-wire and the side-bracket varieties. Centre-pole construction was considered obsolete because the poles usually interfered with the safe operation of motor vehicles as well as trolley buses. In addition, the placement of the poles in the middle of the road usually did not allow trolley buses to reach the curbs of the road. The initial trolley bus route in Edmonton, however, did share the streetcar centre-poles along Jasper Avenue for ½ mile (0.8 km). (Ferrier, 1946, p. 18) Different types of hangers and ears were required for trolley bus lines since any deviation in the thickness or the alignment of the wires could cause the shoes to dewire. Swivel-top hangers were used because they could compensate for the sag in span wires, thus keeping the trolley wires on a vertical plane. Figure 27 (after Canadian Ohio Brass Catalog No. 23, 1940, p. 15) shows the application of the swivel-top hangers in span-wire construction. Clinch ears could no longer be used since the pounding required to clinch them to the wires could frequently kink the wires causing the shoes to leave the wires at those points. Clamp ears were used instead. They were galvanized malleable iron castings that were made in three pieces. Two smaller clamp pieces

were connected to a larger body piece with brass or bronze screws. The body and the clamp pieces gripped the trolley wire tightly without bending it. (Canadian Ohio Brass Catalog No. 23, 1940, pp. 16-17)

New methods of curve construction had been developed for trolley bus lines. For gradual curves, the traditional arrangement of curve hangers was used. For tight curves, such as 90° bends, several pre-formed galvanized steel curve segments were used. These segments, which were manufactured in several degrees of curvature, were designed to be inserted into the wires. With most previously used special work, the trolley wires had to be cut in order to install these items, such as crossovers. The segmented curves, however, had special approach/anchor tips which guided the trolley wires above the curve segment. The trolley wires then passed around curved strain plates that supported the wires in place. The shoes, however, would travel along a steel runner that was parabolically shaped to the correct degree of curvature. The space between the runners and the strain plates usually contained some sort of anti-trapping casting which was intended to prevent a dewired pole from becoming wedged in the curve segment. After passing along the runner, the shoes came into contact with the trolley wires again, which had passed through another set of approach/anchor tips. Several segments were required for most curves. A 90° curve, for example, could be fabricated with two 45° segments. Three 30° segments could also be used. It should be noted that the wires between the curve segments travelled in a straight line. The transition from straight to curve tended to reduce the allowable speed of trolley buses through the curves. This was necessary to avoid dewiring the shoes. The use of special work that did not require the trolley wire to be cut was an improvement that facilitated the construction of overhead lines. Besides ease of construction, segmented curves

required fewer support wires than an assembly of curve hangers, so curve segments were esthetically more pleasant. Figure 28 (after Canadian Ohio Brass Company Catalog No. 23, 1940, p. 26) shows a plan view of a typical segmented curve with the components labelled.

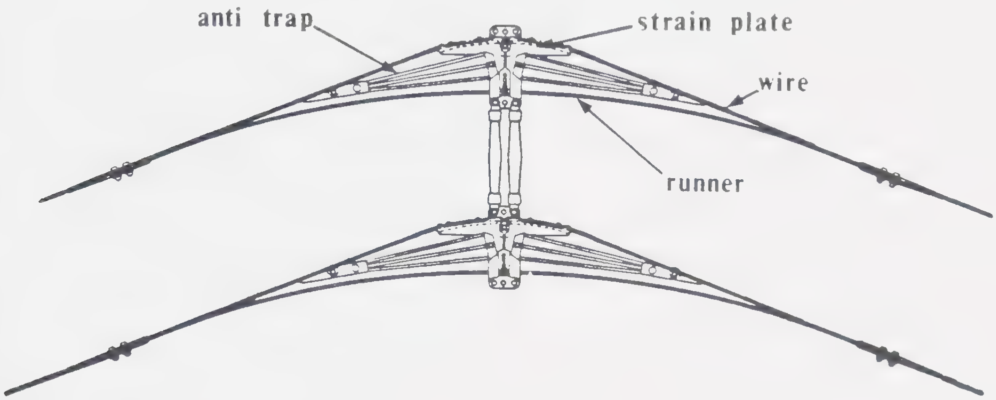


FIGURE 28. OHIO BRASS 45° CURVE SEGMENT

Edmonton's initial trolley bus lines were designed by engineers of the Canadian Ohio Brass Company, the Canadian office of an American concern, that manufactured overhead hardware. (Ferrier, 1946, p. 20) The actual installation of the overhead was done by a local contractor under the supervision of the Canadian Ohio Brass personnel. (CECR No. 15, April 24, 1939) Although there were European manufacturers who produced overhead hardware that provided vertical flexibility to trolley bus wires, the prevalent political climate in Europe at that time, 1938-1939, precluded the consideration of such overhead systems for use on the ERR.

Both positive and negative feeders were required for trolley bus

lines. Initially, positive feeder taps were located at ½ mile intervals, approximately every seventh or eighth pole. Negative feeder taps were usually located at the next pole along from a positive feeder tap. While positive feeders were usually aerially suspended cables, the initial negative feeders were either old streetcar tracks or the buried negative feeder cables. Negative feeder taps, therefore, travelled from the negative trolley wire down to the rails or buried cables. (Power Plant Department Drawing of Trolley Bus Poles and Feeders, October 1938)

Electrical Rectification, 1945-1981

The need for more D.C. capacity became apparent in 1942 when the ERR received three more British trolley buses and ordered three more from the United States (see Appendix I). A new substation at 105th Avenue and 103rd Street was proposed but was not built. (CECR, January 22, 1943) Wartime conditions did not allow most street railways to purchase additional mercury arc rectifiers so the new substation had to be postponed until the end of the War. The new substation was built during 1945 and was equipped with one 1 000 kW Hewittic rectifier. (EL&PDAR, 1945, p. 2) During 1949, the original Hewittic rectifier at the substation at 107th Avenue and 124th Street was upgraded to 1 000 kW. (Wilson, 1949, p. 36)

Other brands of rectifiers were being manufactured by this time but the ETS had been satisfied with the Hewittic type. In 1949, a firm representing the English General Electric Company (GEC) submitted a low bid for a new rectifier. The GEC rectifier operated in the same manner as the Hewittic rectifiers except the GEC unit used steel tubes rather than glass bulbs. The GEC rectifier was purchased despite initial apprehension about the steel tubes. (Letter to the City Commissioners

from Power Superintendent W. I. McFarland, May 12, 1949, p. 2) The rated capacity of the GEC unit was 1 275 kW. The new unit was placed in the substation at 107th Avenue and 124th Street. The original Hewittic rectifier was moved to the substation at 105th Avenue and 103rd Street to supplement the existing 1 000 kW Hewittic unit already there. (Letter to J. L. McGuigan from ETS Superintendent D. L. MacDonald, August 17, 1965)

In 1950, the Power Department decided to eliminate all operators from D.C. substations as a cost-saving measure. To facilitate this, an additional rectifier was purchased so that the water cooled Brown Boveri rectifier at the Cromdale substation could be removed to the power plant. The Brown Boveri rectifier required occasional operator supervision. (Report on Substations by Power Superintendent W. I. McFarland, January 25, 1951) The replacement rectifier was a 1 700 kW Hewittic unit. (Letter to J. L. McGuigan from ETS Superintendent D. L. MacDonald, August 17, 1965) The aggregate capacity of the power supply serving the ETS by the end of 1950 was 7.6 MW. This capacity was far in excess of the system's requirements so the original Hewittic rectifier, which had been producing some unwanted interference with the telephone system, was shut down. (Letter to C. B. Diplock from Commissioner R. J. Gibb, January 19, 1944, and EPAR, 1967, pp. 4-5)

No further changes to the rectification system came until 1967 when the original Hewittic rectifier was moved back to its initial location at the substation at 107th Avenue and 124th Street and reactivated. This was done in order to improve the power supply for trolley buses operating on new lines in the western end of the City. (EPAR, 1967, pp. 4-5) In 1976, the trolley bus system was extended in southern Edmonton. An additional substation in the vicinity was required. A

small building was erected at the southwest corner of 109th Street and 61st Avenue. (Personal Observation by Author) The remaining 1 000 kW Hewittic rectifier at the 105th Avenue and 103rd Street substation was moved to the new substation. (Information from Edmonton Power)

By 1976, construction of the new Light Rail Transit (LRT) system was well underway. The power supply chosen for the new system consisted of solid state rectifiers. Mercury arc rectifiers were considered obsolete, not as efficient as solid state units and hazardous. (Information from Edmonton Power) It should be remembered that mercury arc rectifiers produce heat in operation, which means that some portion of the supply voltage was being dissipated as heat instead of being rectified. In addition, mercury was found to be a toxic material so a hazard existed for repair and maintenance crews.

The rectifiers serving the trolley bus system began to show signs of wear by 1980. By 1981, Edmonton Power determined that the cost of overhauling the original (1929) 1 325 kW Brown Boveri rectifier was greater than replacing it. In 1981, after 52 years of service, the unit was replaced by a solid state rectifier. The second Brown Boveri unit (1930) was also removed from service during 1981. (EPAR, 1981, p. 21) Future plans call for the gradual replacement of all mercury arc rectifiers with solid state units. When this changeover has taken place, the transition from electrical to electronic rectification will be complete.

Power Distribution, 1947-1951

Following the end of the Second World War, the ETS began to expand its trolley bus system. By 1947, many new lines had been installed. The older type of hanger was superseded by a newer design that was clamped to the span wire instead of being hooked onto it. In addition,

the new hanger employed a replaceable molded rubber compound as the insulating material. The insulator was also separated from the surrounding metal shell by an air gap which provided greater protection against electrical leakage as the result of insulator failure. (Canadian Ohio Brass Catalog No. 25, 1948, p. 17) It was mentioned in the previous section on power distribution that moveable frogs or switch points were required where trolley bus lines converged or diverged. At locations where lines converged, trailing switches (sometimes called trailing frogs) were used. As the shoes approached the main set of wires, curved steel runners would be encountered that connected the branch wires to the main wires. As the shoes continued along, they would push the frogs so that they deflected and were aligned with the branch wires, thus presenting a smooth path to the main set of wires for the shoes. The switch points would be reset to their original position by the passing of a trolley bus along the main set of wires. (Canadian Ohio Brass Catalog No. 25, 1948, pp. 52-52A) Where trolley bus lines diverged, however, mechanically operated switch points were required so that the frogs could be aligned to the diverging wires before the shoes reached that point. The ETS used two types of electrically operated frogs; both types were manufactured by the Ohio Brass Company. The first type, known generally as selectric frogs, consisted of two parallel frogs that were each deflected by a solenoid arrangement located on top of the frog. The solenoids were protected by sheet metal covers. A contactor was placed on each wire at a different distance in front of each frog. This staggering of the contactors was arranged so that as a trolley bus started to turn a corner, thus diverging from the straight wires, the shoes would touch each contactor simultaneously, completing an electrical circuit through both solenoids. The switch points, having been deflected by the solenoids,

on, power-off switch) did not employ staggered contactors. Insulated "power" contactors which were arranged in parallel on the wires before each switch caused the solenoids to operate. A power contactor consisted of a short runner that was insulated from the trolley wire and was connected to one of the solenoids. As a trolley bus approached the two power contactors, the operator of the bus could either keep his foot on the control pedal (power-on) or he could remove it (power-off). If the trolley bus was drawing power, an arc would occur as the insulated section of the overhead was reached. The extremely short length of the insulator enabled some power to pass from the shoe into the runner of the power contactor. This action completed a circuit with the solenoid connected to that contactor. Since the contactors were arranged in a parallel fashion, both frogs would be deflected simultaneously and the shoes would travel onto the other set of wires. After passing through the frogs, the shoes would reset the switch points by pushing levers. If a bus was to travel on the main wires, the bus operator kept his foot off the power pedal. No power would pass into the contactors, therefore. The solenoids would not be activated and the trolley bus would continue along the main wires. It should be noted that the power contactors could be located several feet (metres) in front of the switch. In such cases, the wires leading to the solenoids were supported above the trolley wires by means of phenolic insulators which were clamped to the upper portion of the trolley wires. (Canadian Ohio Brass Catalog No. 25, 1948, pp. 60-61) Small rectangular signs were usually placed near TER switches in Edmonton. The signs consisted of a white background with the word "power" printed in red letters. A red arrow, located beneath the word, indicated the alignment of the switch points if power was applied to the contactors. (Photographs and Observations by the Author) This visual

would enable the shoes to travel to the wires leading around the corner. After passing through the frogs, the shoes would strike levers that would return the frogs to their original position. If a trolley bus travelled straight through the switch, the solenoids would not be activated because the poles of the trolley bus would be parallel on the wires, not staggered as in a turn. The shoes would, therefore, touch each contactor at different times so a complete circuit to the solenoids would not be formed. Figure 29 (after Canadian Ohio Brass Catalog No. 25, 1948, p. 58) shows the underside of a typical electrically operated frog which is aligned to the main wire.

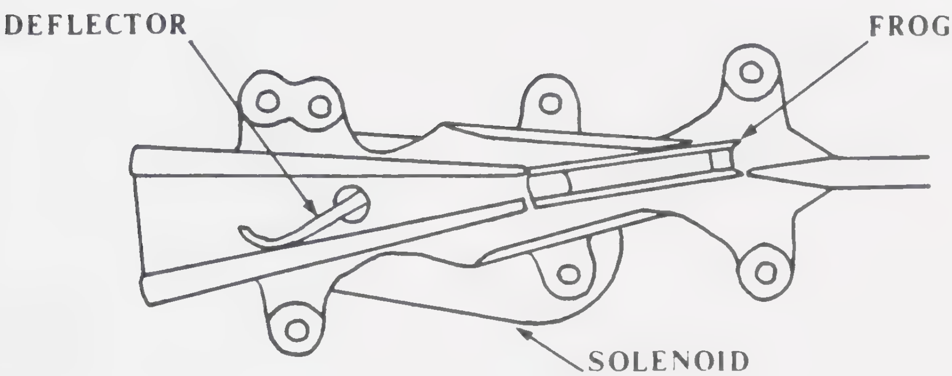


FIGURE 29. UNDERSIDE OF ELECTRIC FROG

The other type of electric frog that was used by the ETS was designated "TER". This type of switch was designed to enable a trolley bus travelling in tangent (a straight line) to be switched onto a parallel set of wires. The operation of a TER frog (often referred to as a power-

aid assisted bus operators with the operation of TER switches.

A new improvement to some section insulators was introduced during this period. In the past, section insulators had consisted of some form of insulated runner which separated live sections of trolley wire. As streetcars and trolley buses passed these insulators, arcing would frequently occur between the current collectors which were on the insulated runners and the end of the trolley wire. The ultimate result of this action was the destruction of the runner. In an attempt to prolong the life of the runners, the Ohio Brass Company developed an attachment for existing section insulators which consisted of a large magnetic coil that was placed above the runner. As the current collector passed from the wire to the runner, current would flow through the coil. This action would cause a strong magnetic field to be formed around the coil. The magnetic field tended to deflect any arc up and away from the runner, thus preventing the latter's destruction. (Canadian Ohio Brass Catalog No. 25, 1948, p. 50A) The use of such magnetic coils was not widespread on the ETS, however, (Observations by the Author)

During this period, a new type of feeder tap was introduced for use in span-wire construction. In previous installations, an insulated cable would be used to connect the feeder cable to a special feeder ear on the trolley wire. The connecting cable was usually secured to the existing span wire. If there were two sets of trolley wires on the span wire, two connecting cables were strung from the feeder to the feeder ears. This arrangement was unsightly and it also added considerable weight to the span wire. The Ohio Brass Company had developed a new system that eliminated much of the hardware and connecting cable hitherto needed for feeder taps. With the new system, when the location of a feeder tap was determined, a special span wire was strung between

the poles. It consisted of two lengths of regular span wire at each end of a length of insulated feeder tap cable. By means of porcelain or wood strain insulators, the middle portion of the span was secured to and insulated from the regular span wires at each end. A small length of feeder tap cable was used to connect the feeder span to the feeder cable. The feeder current reached the trolley wires through specially shaped feeder hangers. These hangers consisted of a length of hickory dowel with castings on each end. The castings were of uneven height in order to compensate for the sag of the feeder span. In this way, the bottom of the hanger assembly would lie horizontally when attached to the feeder span. Both castings were attached to the feeder span but only one of the castings was arranged so that it provided an uninsulated path between the feeder span and the clamp ear. In this fashion, power was fed into the trolley wires. Figure 30 (after Canadian Ohio Brass Catalog No. 25, 1948, p. 35) shows a typical feeder span arrangement for a double trolley bus line. The figure depicts the feeder hangers arranged for negative feeding.

Throughout this period, the use of streetcars declined in favor of trolley and motor buses. By the end of 1948, therefore, the original centre-pole construction along Jasper Avenue, which did not allow proper trolley bus operation, was replaced with span-wire construction. (Memorandum to ETS Superintendent T. Ferrier from Assistant City Engineer J. D. MacDonald, January 14, 1948) In usual practice, streetcar tracks were removed from a street immediately following the termination of streetcar service. In some cases, however, the ETS left the rails in place so that they could be used as negative feeders for the negative trolley wires until a system of aerially suspended negative feeder cables could be installed. An example of this were the tracks along 101st Street

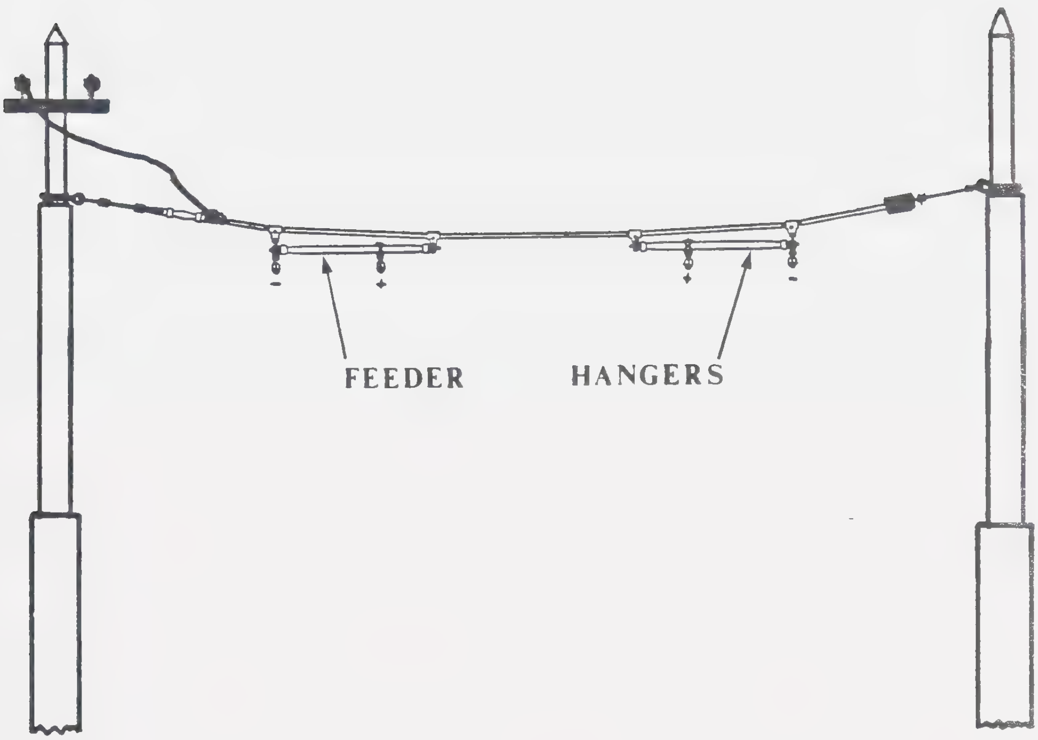


FIGURE 30. FEEDER SPAN ARRANGEMENT

between Jasper and 107th Avenues. Although streetcar service had been withdrawn from 101st Street during 1950, the rails remained in place throughout 1951 because they were being used as negative feeders for the trolley bus wires. (Letter to the City Commissioners from ETS Superintendent T. Ferrier, April 20, 1951)

With the increased use of the trolley bus, the need increased for a line maintenance vehicle that did not travel along rails. Many of the new trolley bus lines did not travel in areas where there were streetcar tracks so it was not possible for the line car to service most trolley bus lines. Although the tower wagon had been sold in 1923, the tower assembly had been retained. Two motor trucks were outfitted for line work during this period. One unit, a 1946 International pickup truck, was fitted with the old wooden tower assembly. In 1947, a larger International flatbed truck was purchased and was fitted with a wooden platform that was raised and lowered by a hydraulic cylinder system. (ETS Statement of Account 22205, January 1960, and Provincial Archives of Alberta Photograph GS 464) Plate 17 (City of Edmonton Archives) shows the 1946 International pickup truck with the wooden tower in line service during the late 1940's.

Power Distribution, 1952-1977

In a 1951 report of an evaluation of the ETS, Stevenson and Kellogg noted that maintenance of the power distribution system was somewhat inefficient because responsibility for it was divided among two departments. The EL&PD was responsible for the feeder lines between the substations and the feeder taps, while the ETS was responsible for the construction and maintenance of the trolley wire system and the feeder taps. (Stevenson & Kellogg, May 1951, p. 106) As a result of the Report's

recommendations, responsibility for the construction and maintenance of the entire trolley bus power distribution system was given to the EL&PD. The ETS, however, still retained the authority to determine the placement of the wires and the type of materials to be used. (Letter to the City Commissioners from ETS Superintendent T. Ferrier, December 19, 1951)

During this period, minor improvements were made to the system. Some trolley bus lines, for example, were moved closer to the sides of the road in order to allow trolley buses to pull up to the curb for passenger loading and unloading. Trolley wheel current collectors were no longer used on the ETS following cessation of streetcar service in September 1951. The need for alloy trolley wire with a high percentage of cadmium became unnecessary because carbon shoe collectors did not abrade trolley wires as much as trolley wheels. In addition, the conductivity of trolley wire dropped in an inverse proportion with the amount of cadmium in the alloy. As early as 1948, many wire manufacturers were producing a "high conductivity" alloy trolley wire specifically suited for carbon shoe collectors. The new alloy was 80% copper and 20% cadmium. This alloy improved the conductivity of the wire without completely eliminating wear resistance. (Canadian Ohio Brass Catalog No. 25, 1948, p. 192) The new alloy wire was installed wherever new lines were constructed or when older wires were replaced. (Letter to the City Commissioners from ETS Superintendent T. Ferrier, December 19, 1951)

A significant change introduced in 1952, which helped to improve trolley bus efficiency, was the use of three 30° curve segments for 90° bends. Prior to this time, such bends had been composed of two 45° segments. ETS Superintendent T. Ferrier stated, "it is found that by

using three 30° curve segments much better alignment is obtained, and in addition operating conditions are improved, resulting in less wear on equipment and longer life of the overhead" (Letter to the City Commissioners, December 19, 1951).

With the termination of streetcar service in 1951, the ground return system of distribution was abandoned in favor of a floating system. It should be remembered that trolley buses obtained their power from two trolley wires, positive and negative. Current could, therefore, travel to and from the rectifier station without passing through the ground. By not using the ground, the problem of electrolysis would be solved. In the past, some negative trolley wires had been fed by connecting them to streetcar rails or to buried feeder cables. The abandonment of the street railway enabled the rails to be removed, which forced the installation of a system of aerially suspended negative feeder cables. Improvements to the feeder system took place gradually but in new construction, the termini of many distant lines were not fitted with a sufficient number of feeder taps. (Observations by the Author) For several years during the 1960's, it appeared as if trolley bus service was going to be removed gradually. In consequence, very few improvements to the overhead took place. (ETSAR, 1966)

By the early 1970's, some portions of the existing overhead were in need of replacement. In an attempt to keep costs to a minimum, in 1971 the City purchased several miles (km) of used trolley wire and the necessary hardware from Winnipeg which had terminated its trolley bus operations. (Letter to ETS Superintendent D. L. MacDonald from Edmonton Power, March 3, 1971) The used material postponed a general replacement of Edmonton's trolley bus lines. Additional used stock was purchased from Calgary in 1975 after that City terminated its trolley

bus operations. The hardware from Calgary was used to extend existing lines in Edmonton. (Edmonton Journal, August 1, 1975, p. 7, and Author's Observations) The use of these recycled materials enabled the trolley bus system to be expanded without great expense. The speed and the efficiency of the system could not be improved, however, until the hardware of the system was improved.

Electronic Rectification, 1976-1981

During 1974, the City began the construction of a Light Rail Transit (LRT) system. The electrically-powered vehicles to be used on the system were to travel along a private right of way which was located underground as well as on the surface. Consideration had to be given to the type of electrical power to be used and how it was to be produced. The type of vehicle purchased for the system was powered by two motors, each with a rating of 150 kW, using 600 volts D.C. (Siemens Specifications for Edmonton Light Rail Vehicles, 1977, p. 4) In normal operation, therefore, each vehicle could require approximately 300-400 kW of power. The power required was much greater than that required by individual trolley buses in Edmonton (see Appendix I). Initially, 14 LRT cars were ordered with the intention of augmenting that number at an early date. In order to avoid the spectre of power shortages along the LRT route, a total of 5 substations were planned. With the exception of the substation serving the lines at the Cromdale maintenance facility (the old streetcar barns), the substations were located at approximately 1 mile (1.61 km) intervals. (Edmonton Power Drawing of LRT Positive Feeder System, 1983)

Advances in electronic technologies rendered the mercury arc rectifier an obsolete and expensive means to rectify A.C. Smaller, more

efficient and less hazardous solid state rectifier units were selected for the LRT substations. Most solid state rectifiers designed for heavy traction service had a maximum capacity of 1 000 kW. The capacity of each substation was to be 2000 kW so two solid state units were installed in parallel in each substation. (Edmonton Power Drawing of LRT Positive Feeder System) Only one substation was constructed underground during this period. It was located at the Churchill station and it contained 2 Brown Boveri 1 000 kW solid state rectifiers. The three other substations which served the LRT line proper were located near Stadium station, Coliseum station and Belvedere station. Each of these substations contained 2 1 000 kW solid state rectifiers that were manufactured by the British firm of Fosters. (Information from Edmonton Power)

The operation of solid state rectifiers differed from that of mercury arc units. The three phase A.C. supply, as well as the auto and interphase transformers, were still required. The significant difference was with the actual rectifier unit. Instead of using a complex array of anodes and a mercury cathode, solid state rectifiers used 4 large diodes and the necessary auxiliary connections to rectify A.C. (Edmonton Power Schematic Drawings of Solid State Rectifiers, 1983) A solid state diode can be defined as a two-electrode semiconductor that contains a junction of P-type and N-type material. The properties of the adjoining materials are such that they will allow current to flow through the diode in only one direction, from the anode to the cathode. (Handel, 1971, pp. 331-333) Each rectifier unit contains 4 diodes that are connected to the windings of the interphase transformer in such a manner that the output of the rectifier is a constant value of 600 volts. (Edmonton Power Schematic Drawings of Solid State Rectifiers, 1983) The diodes, which

are housed in a sheet metal cabinet, require only natural air flow for cooling. The diodes, unlike mercury arc rectifers, generate little heat so that elaborate cooling systems are not required. (Information from Edmonton Power) Although each unit is rated at 1 000 kW capacity, the design of the units enables them to be overloaded 300% for a period not longer than 4 minutes. While most mercury arc rectifiers could be overloaded 200% for brief periods (no longer than 1 minute), they were not as rugged as the solid state rectifiers. (Edmonton Power Specifications of Solid State Rectifiers, 1983)

When the LRT line was extended to the northeast in 1980, an additional substation was constructed near the Clareview station. (Edmonton Power Drawing of LRT Positive Feeder System, 1983) The new substation was equipped with 2 rectifier units of 1 000 kW capacity each which were manufactured by Siemens of Germany. (Information from Edmonton Power) Rectifier installations to this time have been equipped with units of European manufacture. Economic considerations have been the primary reason for this since the Canadian dollar was weak in relation to the American dollar, but was strong compared to most European currencies. European goods were, therefore, significantly cheaper than goods manufactured in North America. Future extensions of the LRT system will require the construction of additional substations which will, most likely, be powered by solid state rectifiers. It should also be remembered that the mercury arc rectifiers serving the trolley bus system are gradually being replaced by solid state units. (See previous section on Electrical Rectification)

LRT Power Distribution, 1977-1980

LRT vehicles, like streetcars, require a track to travel on in addition

to a system of D.C. power distribution. The distribution system for the LRT system in Edmonton differs radically from the distribution system that was used for the street railway. A ground return system was used by the street railway in which the current would, ideally, return to the generating station or the substation through the rails or through buried feeder cables. In most instances since the rails were in physical contact with the ground, some current would travel through the ground or through pipes causing serious damage (electrolysis). A semi-floating system of distribution was selected for use on Edmonton's LRT system to prevent electrolysis from occurring.

The rails, whenever possible, were insulated from the ground by means of treated wooden ties or by rubber pads that were placed between the rails and the rail supports. In this manner, there were few opportunities for current to leak from the rails to the ground. In addition, since the rails were not surrounded by pavement, there were few locations where the rails were in physical contact with the ground. Most rail sections as well were joined by thermit welds so there were few locations in the rail where excessive resistance would be encountered. Where angle bar joints were required, at the ends of signal circuits for example, special rail bonds were used to ensure good conductivity between the rail sections. Impedence bonds were used which allowed only certain types of electrical power through them. In this manner, the individual signal circuits could be isolated from one another. The liberal use of negative feeder taps, at least two in each substation territory, and the placement of the substations near the tracks also served to prevent return current from travelling through the ground or through pipes. (Edmonton Power Drawing of Rapid Transit Negative Feeders, 1977) Because the rails were insulated from the ground, a safety device was connected

between the rails and the ground. This device, called a potential detector, measured and compared the voltages in the rails and the ground. The purpose of the potential detector was to prevent an electrical hazard from existing between the rails and the ground should a hazardous condition arise. In normal operation, there would be little measurable difference (potential) between the rails and the ground. If, for example, a trolley wire broke and touched the ground, there could be a potential difference between the rails and the ground of up to 600 volts. Anyone who touched both a rail and the ground would complete a circuit between the trolley wire and the rail. The person would, therefore, be electrocuted. The potential detector was designed to prevent this from occurring. If the measured potential difference was about 15 volts D.C. for a period greater than 15 seconds, the detector would sound an alarm in the control centre. If, however, the potential was greater than 45 volts D.C., the detector would cause relays to close which would connect the rails to the ground, thus eliminating a potentially fatal hazard. (Information from Edmonton Power, and Siemens Catalog FM, 1979, § 13 p. 9)

The suspension used for the trolley wire was also significantly different. The street railway and the trolley bus system in Edmonton had used a fixed suspension where the trolley wire was, usually, rigidly supported at set intervals of several feet (metres). The trolley wire could move some distance both laterally and vertically. As the ambient temperature fluctuated, the trolley wire would sag or tighten. With low speed vehicles such as streetcars, these changes in the trolley wire had little effect upon operation. A fixed system used with fast accelerating, high-speed vehicles, such as LRT cars, would cause the current collector either to dewire or to bounce along the wire. The bouncing would cause arcing and, therefore, damage to the collector and to the

trolley wire. (Siemens Catalog FM, 1979, § 1 p. 2) For high-speed operation, a type of suspension was required that reduced the effects of temperature change on the wire to a minimum. Such a system, which had been used on many high-speed electric railroads for many years, was known as "catenary" suspension. (Doane & Parkham, 1926, § 18 p. 30) Typical catenary construction, which was installed on the surface portion of Edmonton's LRT system, consisted of a series of steel H columns that were spaced about 55 m apart and which were mounted vertically on reinforced concrete bases usually located between the tracks. The columns, referred to as masts, stood approximately 6 m high. In later construction, the masts were ccnstructed of hollow square steel beams with pre-drilled holes for mounting the necessary suspension hardware. (Information from Edmonton Power) The mast arrangement, similar to street railway centre-pole construction, supported special cantilever brackets on the sides of the masts facing the tracks. In normal application, the horizontal "arm" of the bracket consisted of a galvanized steel cable guy wire insulated from the mast by means of a hinged insulator which held a steel strut tube at a 65° angle from vertical. The strut tube was secured to the mast with another hinged insulator located approximately 1 400 mm below the guy wire. In areas where the overhead assembly would be in compression (on a descending grade for example) the guy wire would be replaced by a steel tube. (Edmonton Power Drawing of Standard Cantilever, 1977) The tops of the strut tubes were fitted with insulators that could secure a stranded copper cable. This uninsulated cable, approximately 13 mm in diameter, was strung along the tops of the strut tubes and was allowed to sag naturally between each bracket. The cable, which was referred to as the messenger wire, followed a catenary curve between support points. The messenger was also strung

so that the lowest point of each curve was the same height above the tops of the rails. (Doane & Parkham, 1926, § 18 pp. 31-32) A tubular steel cantilever (supported at one end only) arm was attached to the support tube of each bracket by a hook assembly. These cantilever arms, which had small insulators and clamp ears connected to their free ends, were designed to hold a trolley wire, or contact wire as it was referred to in this application, so that it would not move laterally but could move vertically and longitudinally. The contact wire used was 4/0 Brown and Sharpe gauge, grooved hard-drawn copper wire. It was strung dead along the line. (Information from Edmonton Power) In a manner similar to that used in the installation of the original street railway wire along Jasper Avenue in 1908, the LRT wire was unreeled from a push cart. Instead of using a wooden tower, crews used hydraulically elevated platforms mounted on trucks equipped with flanged wheel attachments in order to connect the wire to the supports. (Author's Photographs and Observations) The contact wire was intended to be supported at a height of approximately 5 m. This was accomplished by attaching the wire to the cantilever arms and by securing the wires, by means of small clamp ears, to thin wire loops attached to the messenger wires. These loops, which were of varying lengths according to the height of the curve, were evenly spaced between support masts and effectively prevented the contact wire from sagging between masts. This arrangement was flexible so the current collector would not bounce as it moved along. (Siemens Catalog FM, 1979, § 1 pp. 2-5) In later construction, the height between the contact wire and the top of the rails was standardized to 5.81 m. This height was thought to provide smoother operation of the current collectors. (Information from Edmonton Power) Figure 31 (after Edmonton Power Drawing of Standard Cantilever, 1977) shows the appear-

ance of a standard cantilever support assembly used in Edmonton. In the initial construction, most of the hardware was supplied by the Swiss Brown Boveri Company. In subsequent construction, both the German Company Siemens and the Swiss Kummler and Matter Company supplied the required hardware. (Information from Edmonton Power) It should be noted that while some of the insulators were made of porcelain, others were composed of cast resins. (Siemens Catalog FM, 1979, § 6 p. 1)

In order for a catenary system to operate successfully, the contact wire had to be divided into sections. Each section was attached to a weighted tensioning device at each end and these tensioning devices were located on masts placed near the sides of the track. The tensioning devices were designed to exert a constant tension on the wire through a system of weights and pulleys. As the ambient temperature rose and the wire expanded, the weights would descend, thereby maintaining the tension and the straightness of the wire. The hinged insulators of the cantilever supports enabled the entire section of wire to move longitudinally. In this manner, the contact wire did not sag or become unnecessarily stretched. A safety feature was incorporated into the tensioning devices. If the contact wire should break for any reason, the weights would naturally attempt to descend quickly. This rapid action could injure people in the vicinity by the falling weights or by the rapid motion of the broken wire. If a break did occur, however, the large pulley of the tensioning device which had ratchet-like teeth along the circumference would fall against a bracket which held a fixed metal bar. The bar would engage the teeth on the pulley, thus preventing the weights from descending. Serious damage, therefore, could be avoided. (Siemens Catalog FM, 1979, § 9 p. 1) The individual sections of contact wire had to overlap in order to prevent power from being cut to the vehicles

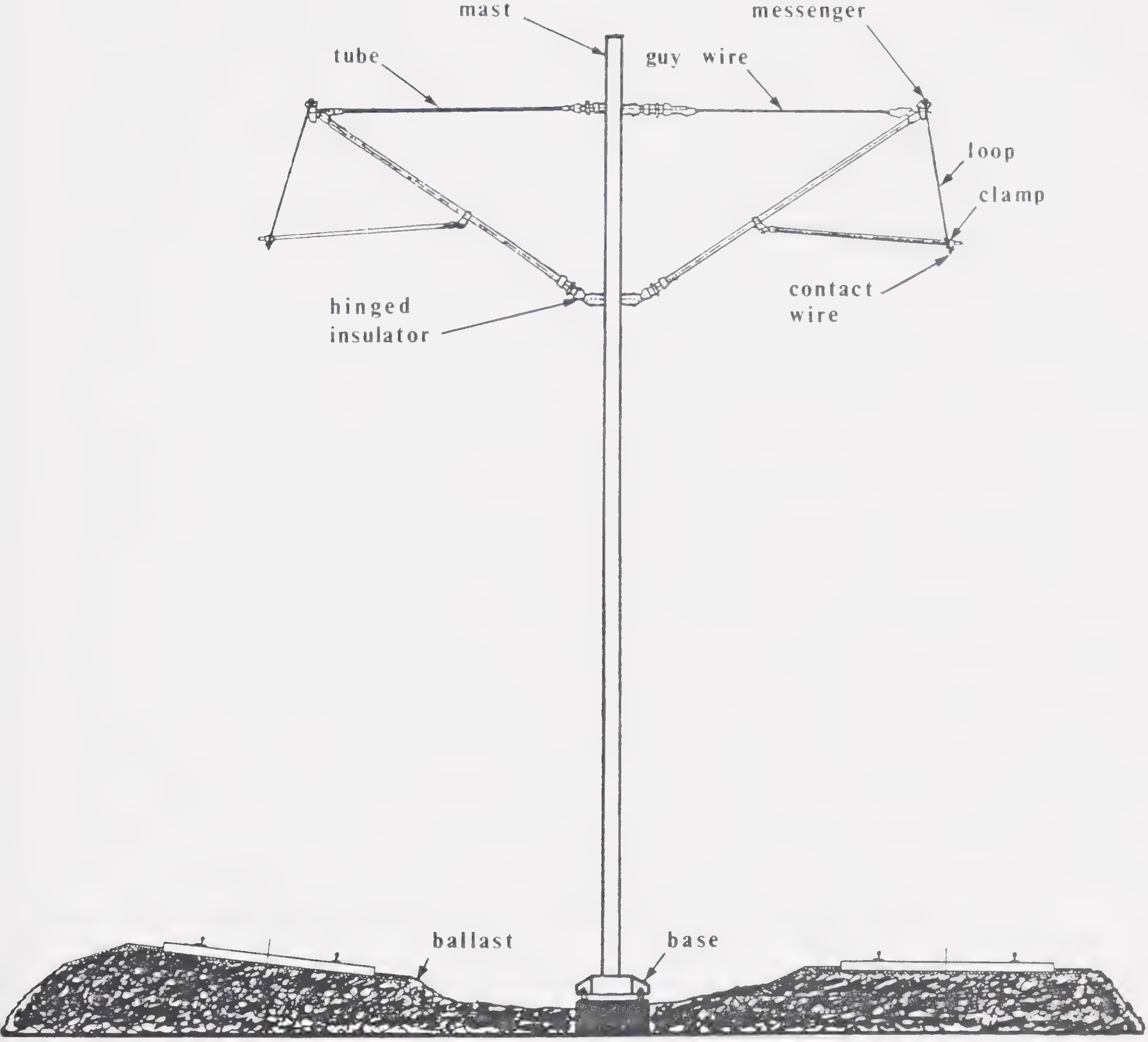


FIGURE 31. CATENARY CANTILEVER SUPPORT

as they passed from one section to another, since the wires were attached to the tensioning devices which were located to the side of the track. In order for this arrangement to be effective, a current collector was required that did not have to follow the path of the wire exactly. The chief disadvantage of both trolley wheels and shoes was that they had to travel along a continuous and smooth surface without jumping off. In high-speed operation, a dewirement could seriously damage either the overhead or the current collector. In addition, special fittings such as electric frogs were required with such collectors. Catenary construction did not lend itself to the use of such current collectors. A wide collector that simply touched the underside of the wire wherever it was placed laterally was what was needed. A common form of this type of collector was known as a pantograph. This device consisted of one or two steel bars arranged perpendicular to the wire in which were placed renewable compressed carbon bars. This comprised the actual current collector. The collector was supported by either one or two tubular frames located on either side of the collector which allowed the collector to be raised and lowered. Springs or air cylinders kept the carbon bars in contact with the contact wire and other springs or air cylinders dropped the pantograph when it was not in use. (Dover, 1929, pp. 203-204) Edmonton selected a half-pantograph for its vehicles. The two carbon bars in this device were supported by a single frame. The contact surface of the device allowed the contact wire to be moved 512 mm to either side of centre. (Siemens Drawing of Halbscherenstromabnehmer "Half-Scissors Current Collector", 1976) In order to prevent a groove from being worn in one portion of the carbon bars, the contact wire was installed so that it wandered laterally between the individual support masts. It is for this reason that the insulators and ears attached to the cantilever arms

could be moved along the length of the arm and secured at any point. (Siemens Catalog FM, 1979, § 1, and Information from Edmonton Power)

Underground installations and enclosed stations could not use the traditional catenary construction. Height constraints precluded the use of a messenger wire. In such areas, a specially designed elastic support arm was used to suspend the contact wire. The arm was secured to either the roof or to a steel bracket and was insulated from the same. A pre-set coiled spring inside the arm assembly provided downward thrust on the arm. This arrangement, combined with the tensioning device, enabled the contact wire to be suspended at a constant height while also providing vertical elasticity to the contact wire. Unlike catenary supports, the elastic supports were placed every 8 to 12 m. (Siemens Catalog FM, 1979, § 7) In the initial construction, however, the arms were arranged so that the contact wire travelled straight through, not moving laterally. After several months of operation, it was discovered that these short distances of straight contact wire were wearing large grooves in the half-pantographs' carbon bars. In order to alleviate this problem, crews altered the lengths of the elastic support arms by the addition of varying lengths of fibreglass rod. In this way, the contact wire was deflected laterally through enclosed areas. (Information from Edmonton Power) It should be noted that the catenary hardware manufacturers did produce entire cantilever arms fabricated from fibreglass. These were not used in Edmonton because it was felt that the extreme local temperature fluctuations might cause the fibreglass to fail. Steel tubing, therefore, was used exclusively.

An extensive positive feeder system was installed on the LRT from its beginning. The contact wire was divided into sections no longer than 1 km. Each section was insulated from the other by means of section

insulators (sometimes called isolators). These devices, unlike those used on the trolley bus system, employed two fibreglass runners to isolate the sections. In surface areas, the messenger wire acted as the feeder cable. Power was fed into the messenger from the substation at 2 points in each section. (Edmonton Power Drawing of Rapid Transit Positive Circuit Layout, 1977) The messenger, in turn, was connected to the contact wire at least 3 times in the section. The messenger and the contact wires were connected by two loops of stranded copper wire which was similar to the wire used for the messenger. One loop was attached to the messenger by means of clamps while the other loop was attached to the top of the contact wire by means of ears. The two loops were joined with clamps where they touched. This arrangement was designed not to interfere with the vertical flexibility of the contact wire. While some feeding took place through the loops which held the contact wire at the correct height, the loops were not designed to be feeders since their small diameter limited the amount of current they could carry. (Information from Edmonton Power) In underground and enclosed sections, traditional insulated feeder cable and feeder ears were used.

It should be noted that the LRT power distribution system was isolated from the trolley bus power distribution system. At locations where trolley bus lines crossed the LRT system, a special unit of special work was installed in the LRT contact wire. This special work, which consisted of fibreglass supports and shaped copper bars, was suspended from insulated guy wires located above the trolley bus and the LRT lines. The special work was assembled so that the copper bars guided the pantographs down below the level of the trolley bus wires. As the pantographs continued, they engaged other copper bars which carried the pantographs across the trolley bus wires without touching them.

The copper bars were so arranged that they did not interfere with the passing of trolley bus shoes. (Author's Photographs and Observations) In this manner, the two systems were insulated from one another even at points where they crossed. The isolation of one system from the other prevented electrical problems in one from affecting the other.

The LRT system was also protected from lightning and short circuits. Each electrical section was protected by circuit breakers. The entire feeder and rectifier system was also protected by lightning arresters which were located at every substation and at locations where feeder cables reached the masts. (Information from Edmonton Power)

Trolley Bus Power Distribution, 1978-1981

During the mid 1970's, the City purchased some new trolley buses (see Appendix I). The purchase of new rolling stock diminished the likelihood that the system would be abandoned. In order to make the system function more efficiently, the rebuilding and refurbishing of the overhead had to take place. Improvements were also made to the safety of the system. It should be remembered that most street railway crossings of railroad tracks had required the use of National trolley guard. This material, although initially required for trolley bus crossings with railroads, was no longer used. (Author's Photographs) It had been found that the trolley guard did not always provide current to a dewired shoe. In addition, it was possible for a shoe to snag on portions of the trolley guard. The results of this could be disastrous for both the overhead and the trolley bus. (Information from Edmonton Power)

During 1979, a new type of overhead suspension was introduced. It has been mentioned previously that both the street railway and the trolley bus system had used a fixed system of overhead. The major

disadvantage of such a system was that as the trolley wires expanded and contracted with changes in the ambient temperature, they would either sag or become extremely rigid. Both conditions were conducive to dewirements. As early as the 1930's, however, the Swiss firm Kummler and Matter (K&M) developed a system of overhead suspension that enabled the trolley wire to move vertically at the suspension points, thus reducing the likelihood of dewirements at those points. (Wittgenstein, 1951, pp. 59-63) A system that imparted vertical flexibility to the trolley wires as well as being able to compensate for the expansion and contraction of the wires due to temperature changes would improve trolley bus operation. The K&M system employed a series of hangers and special ears which were connected by two short lengths of solid wire. The wires were arranged so that a parallelogram was formed between the hanger and the ear. These arrangements, called pendulums, were referred to locally as "trombone hangers". (Information from Edmonton Power) As a shoe passed beneath the ear, the trolley wire could be deflected upwards because of the loose connection between the ear and the hanger. The deflecting trolley wire would tend to tighten as it moved since the parallelogram arrangement forced the trolley wire to the side as well as up. (Modern Trolleybus Overhead Contact Lines, 1983, pp. 4-5) By staggering the direction of the pendulums, the trolley wires would tend to follow a zig-zag pattern. This lateral arrangement of the wires coupled with the action of the pendulums enabled the trolley wire to maintain a constant tension despite changes in the ambient temperature. If, for example, the temperature dropped and the trolley bus wire contracted, the pendulums would be pulled downwards. This action would reduce the length of the trolley wires between the poles (the zig-zag) while maintaining a constant tension on the wires. Figure 32 (after Modern Overhead

Contact Lines, 1983, p. 5 & p. 8) shows the plan and sectional views of a typical K&M overhead installation. It should be noted that the 700 mm spacing of the trolley wires, required to prevent the pendulums from accidentally touching, is somewhat greater than the standard 24 inch (610 mm) trolley wire spacing that was used in previous construction.

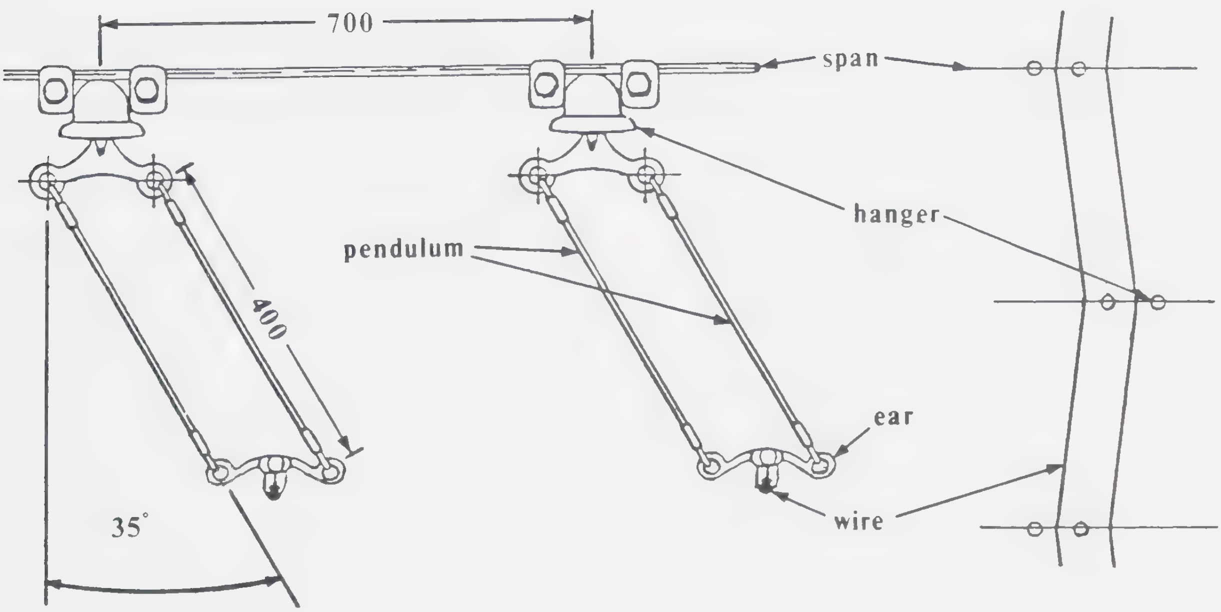


FIGURE 32. SECTION AND PLAN VIEWS OF KUMMLER & MATTER FLEXIBLE SUSPENSION

The K&M system could also be applied to curve segments and to other pieces of special work including section insulators (isolators). (Edmonton Power Drawings of K&M Special Work, 1983) The K&M Company also offered a new type of switch that had been developed during the 1950's.

It should be recalled that the two types of trolley bus switches used in Edmonton to this point required the wires to be fitted into clamps attached to the switch assembly. In order to do this, the trolley wires had to be cut. In addition, the switches were usually suspended by the trolley wires and by steel guy wires fastened to eye lugs cast into the side of the switch assemblies. Much of the longitudinal stress, therefore, was borne by the trolley wires and the switch castings. The switch manufactured by K&M could be installed without cutting the trolley wires. When the trolley wires were installed, they were arranged so that the diverging set of wires were placed on top of the wires travelling straight. The diverging wires, in addition, were extended to the nearest pole where they were fastened to it by strain insulators. The switch frogs and runners were then placed into the wires. Through a system of transition tips (formerly referred to as approach/anchor tips) the diverging set of wires were guided above the main wires. Insulators served to isolate the different polarities of the wires. Elliptically-shaped copper tubes comprised the runners that the shoes travelled along in order to pass from the main set of wires to the diverging set. Figure 33 (after Edmonton Power Drawing of a K&M Electric Switch, 1983) shows the plan view of a K&M switch.

The traditional methods of activating electric frogs, with contactors, were abandoned with the introduction of the new overhead hardware. Radio control units connected to the frog solenoids and to an antenna mounted on the negative trolley wire enabled the operator of a trolley bus to set the switch frogs without slowing down for contactors. A transmitter mounted in the trolley bus which was controlled by the operator could produce two distinct signals. A small antenna mounted near the top of the negative trolley pole emitted the signal that would cause

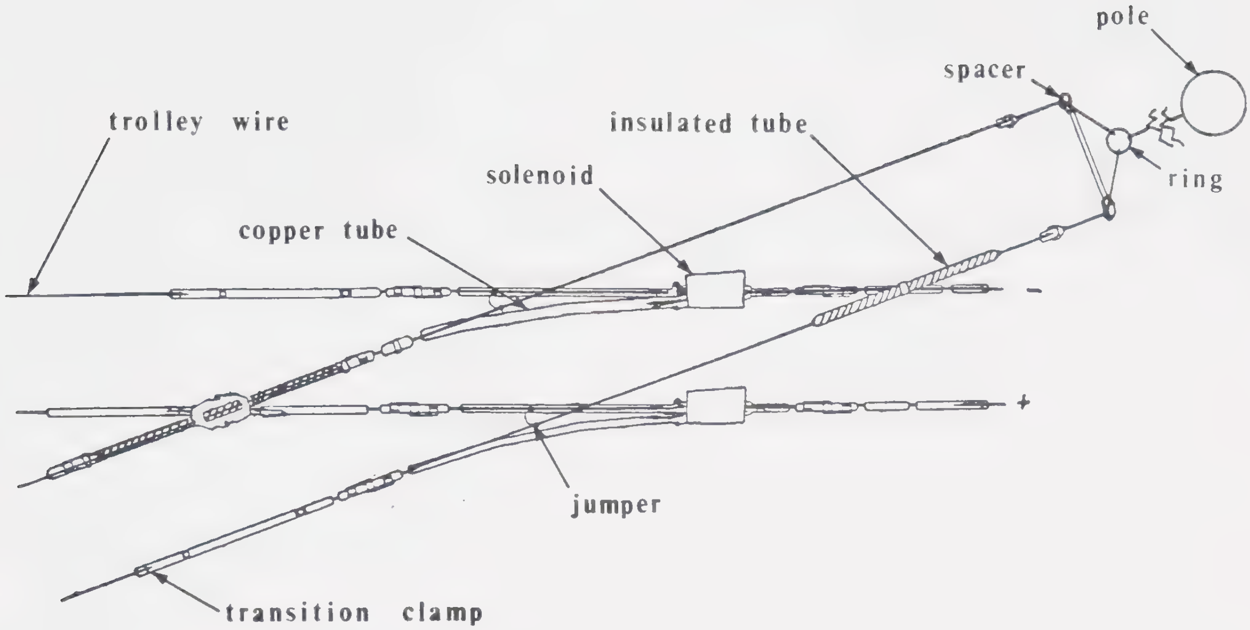


FIGURE 33. PLAN VIEW OF A K&M SWITCH

the control unit either to maintain the position of the frogs or to switch their alignment. To further assist operators, many switches were equipped with two indicator lights which displayed directional arrows to indicate the alignment of the frogs. The indicator lights were usually placed near the switch, to the left side. (Information from Edmonton Power and Author's Observations)

The use of K&M elastic hardware meant that the positive and negative feeder hangers could no longer be used. Feeder taps reverted to the earlier system of feeder ears connected to the feeder cable by short lengths of insulated cable. This type of feeder tap did not interfere with the vertical movement of the pendulums. (Information from Edmonton Power) Wherever possible, feeder taps were placed an equal distance

apart. Feeder taps were placed at approximately every fourth to fifth pole since a standard distance between poles had been introduced. (Information from Edmonton Power)

The introduction of elastic overhead provided crews with an opportunity to install new support poles. Wherever possible, a standard distance of about 33 m was used. (Information from Edmonton Power) In most previous construction, wooden or metal poles were set into holes in the ground and were secured with concrete or tamped earth. If the pole was set incorrectly, moved, was damaged or was no longer required, great expense was involved in replacing it. In order to avoid these problems, a system was devised whereby poles could be bolted to a substantial concrete base. To do this, holes were bored with mechanical augers at the appropriate locations. Steel reinforced concrete was then deposited in the holes in addition to 4 large-diameter studs. A substantial distance of the threaded portion of the studs were left above ground level. After the concrete had hardened, nuts were placed on each stud. Heavy-gauge octagonal steel poles with flanges attached to their bases were then placed on the studs and bolts. An additional set of nuts were used to secure the pole bases to the first set of nuts. By adjusting the two nuts on each stud, the pole could be set at any desired angle, or it could be set plumb in all directions. In addition, the poles were designed to shear from their bases if they were struck severely. (Edmonton Power Drawings of Trolley Pole Slip Base and Anchor Bolt & Reinforcing Cage Assemblies, 1983) During this period, new materials were introduced for span wires. In all previous construction, span wires had consisted of stranded galvanized steel wire. Advances in the technology of plastics enabled manufacturers to produce synthetic span ropes which were not only lighter but were as strong as the steel span wires they replaced.

An additional advantage of synthetic span ropes was that they did not easily conduct electricity so they served as added protection against insulator failure. (K&M Catalog, 1980, p. 9) Improvements were also made to side-bracket construction.

Many new and rebuilt trolley bus lines used side-bracket construction. In the past, the brackets and their guy wires were affixed directly to the poles. A safety hazard existed, however, if metal poles were used. If, for instance, a trolley bus was travelling along a line and its negative pole dewired, it was possible that the pole could strike either a bracket arm or a guy wire. If this occurred, it would be possible that a circuit would form between the trolley bus and ground, the pole being used as part of the circuit. A person leaning against the pole or standing in the immediate vicinity could be electrocuted. In addition, if a tall vehicle were to strike trolley bus wires suspended by side brackets, it would be possible that much of the overhead would collapse because the side-brackets were rigidly connected to their poles. In order to overcome these hazards, a new type of side bracket assembly was designed locally. The bracket was to be insulated from the pole in addition to being made able to swing to either side. The actual bracket arm was insulated from the pole by the use of a hinged insulator similar to the ones used on the LRT catenary. The insulator allowed the assembly to swing should the overhead be struck sideways. The guy wires which supported the bracket arms were insulated from the poles by the use of elliptically-shaped fibreglass strain insulators. (Edmonton Power Drawings of Cantilever Construction, 1983)

Special consideration had to be given to the design of overhead suspension when it was decided to operate trolley buses across the lower deck of the High Level Bridge. The low height on the lower deck pre-

cluded the use of elastic overhead as well as traditional span-wire or side-bracket construction. The City, furthermore, was not allowed to drill holes into nor to weld items onto the superstructure of the bridge. (Information from Edmonton Power) A modified fixed system was devised for use on the bridge. Sheets of plywood were attached by clamps to the underside of the upper deck. A corrugated, non-combustible, insulating material was then bolted to the plywood. Small hangers were then bolted through the insulating material and the plywood and the trolley wire was strung. This system worked for a brief time but failed because the longitudinal movement of the bridge sections was greater than the movement of the trolley wires. A modification had to be developed that would enable the bridge to move without damaging the trolley wires. The Edmonton Power engineers accomplished this by attaching the hangers loosely to short lengths of slotted square tubing. With this arrangement, the bridge movements did not affect the tension of the trolley wires. (Information from Edmonton Power)

The upgrading of the trolley bus electrical distribution system that has taken place involved not only the application of new technological systems, but has also required the development of locally-designed hardware to solve unique problems indigenous to Edmonton.

Chapter V

Street Railway Rolling Stock, 1908-1951

Introduction

Although the construction of the street railway in Edmonton had begun in 1907, no rolling stock was ordered until August 1908, at which time the initial construction of the system was nearing completion. As early as September 1907, the City was considering the number and the type of rolling stock to be purchased. At that time, a total of eight large electrically powered passenger cars, each equipped with four 50 H.P. (37 kW) motors, were thought to be required for the track already under construction. (Railway and Marine World, September 1907, p. 683, see Chapter III for the extent and the location of the track constructed during 1907) By the beginning of August 1908, the City of Edmonton had purchased the interests of the Strathcona Radial Tramway Company and had begun to construct a streetcar line to Strathcona. (Railway and Marine World, September 1908, p. 665) This new line was to reach that City, which was situated on the south side of the North Saskatchewan River, by a bridge which was located at the base of the extremely steep grades on either side of the river. (ERR Drawing of Profile of Lines, December 1908)

It would seem that extensions of the street railway trackage would mean that the total number of streetcars required would be greater than the eight originally estimated. The City of Edmonton, however, had a serious shortage of funds at this time so attempts were made to reduce capital expenditures. (Letter from Mayor W. A. Griesbach to "Public Service", October 16, 1907) By the middle of August 1908, it appeared

as if the street railway system would be ready for operation by the end of the year. Passenger equipment, therefore, had to be ordered if the street railway was to be able to operate.

Passenger Equipment, 1908

The design of street railway passenger cars was fairly consistent by 1908. Many Canadian cities had electric street railways so Edmonton was not attempting to obtain exotic equipment. Although most of the manufacturers of the track and electrical distribution systems were foreign, there were several well-established manufacturers of streetcars in Canada. The main advantage of Canadian streetcars over American ones was that Canadian built streetcars usually cost less. In addition, Canadian streetcar manufacturers tended to equip their products to better withstand the severe winter weather in this country. (Letter to the City Commissioners from ERR Superintendent C. E. Taylor, March 18, 1910)

The first streetcars for the ERR were ordered in August 1908 from the Ottawa Car Company of Ottawa, Ontario through a local jobbing firm. (Agreement between Gorman, Clancey & Grindley, and the City of Edmonton, August 20, 1908; Ottawa Car Co. Contract for Streetcars, September 3, 1908) A total of seven streetcars were ordered. Six of these were long vehicles which could seat 40 passengers, while the seventh was a shorter car that could seat 32 passengers. (Ottawa Car Co. Specifications for Streetcars, July 31 and August 1, 1908) Despite the estimates of September 1907, the City officials believed that seven streetcars would be able to provide adequate service on the existing lines of the ERR. (Edmonton Journal, August 18, 1908, p. 1)

The type of streetcars that were ordered were known as double-end, semi-convertible cars. The term "double-end" meant that each end

of the streetcar was identical and, if the appropriate electrical equipment were installed, it could travel in either direction. The term "semi-convertible" referred to the construction of the streetcar's body. There were three general types of streetcar bodies: open; closed; and semi-convertible. (Doane & Parkham, 1926, § 22 p. 46) Open cars consisted of a frame and a roof supported by several vertical posts. Open cars were designed for summer use and for areas with a warm climate. Closed cars, which were designed for winter use, consisted of a frame, roof and substantial sides which contained a number of small, usually unopenable, windows. Semi-convertible cars were designed for use throughout the seasons. Such car bodies consisted of a frame, roof and sides which contained windows which ran the entire length of the car body. These windows were designed to slide into roof pockets or to drop into pockets in the sides of the body during warm weather. When the weather was cold or was inclement, the windows could be closed. (Doane & Parkham, § 22 pp. 46-47) The ends of the car bodies were strengthened by a framework known as a "bulkhead". Each bulkhead contained a door to enable passengers to enter and leave the streetcar body. The body was usually supported by wheels. In such cases, the floor of the body was too high for passengers to step up to from the street. In order to enable passengers to enter the body easily, platforms or vestibules were placed at each end of the body. The vestibules of the first ERR streetcars consisted of a semi-circular shaped platform which was affixed to the frame of the car body. The floors of the vestibules were set so that they lay several inches (mm) below the floor level of the body. The vestibules were enclosed at the sides and tops and contained several doors and windows that could be opened. (Ottawa Car Co. Specifications for Streetcars, August 1, 1908) Steps located on either side of the

vestibules enabled the passengers to enter and exit from the streetcar easily.

The main body frame of the first ERR streetcars, which was rectangular in shape, was composed of wood. Wood had long been used as a construction material for both streetcars and railroad rolling stock. (Cyclopedia of Applied Electricity, Vol. III, 1908, p. 70) The wooden frames were reinforced with steel plates and by a system of metal trusses. The longitudinal parts of the frame consisted of four long wooden beams called sills that were cut to the length of the car body. Two sills, referred to as side sills, formed the long sides of the frame. The two remaining sills, called intermediate sills, were placed several inches (mm) to either side of the centre-line of the frame. The intermediate sills supported the floor of the body as well as bolsters. Bolsters were metal devices which held the trucks to the car body. Georgia pine was used for the sills since that wood could be flexed a certain degree without breaking or cracking. (Ottawa Car Co. Specifications for Streetcars, August 1, 1908, p. 2) The end sills and the cross pieces which held the side and intermediate sills in position, and which were not exposed to much flexing, were formed of white oak. All the pieces of the frame were connected with mortise and tenon joints that were subsequently secured with several 5/8 inch (16 mm) diameter steel bolts that were parallel to the end sills. These bolts, which were spaced along the length of the car body, were designed to be left exposed so that crews could tighten them as the frame joints became loose. The frames of the six longer streetcars measured 20 feet 10 inches (6 350 mm) long by 8 feet (2 438 mm) wide. (Ottawa Car Co. Specifications for Streetcars, August 1, 1908, p. 1) The frame for the shorter streetcar measured 20 feet 10 inches (6 350 mm) long by 8 feet (2 438 mm) wide. (Ottawa Car

Co. Specifications for Streetcar, July 31, 1908, p. 1) Wooden frames of such lengths could not support themselves when heavy weights were placed on them. In order to strengthen the frames, the bottoms of the side sills were reinforced with 5/8 inch (16 mm) thick steel plate which ran along the entire length of the sills. This reinforcing was not sufficient to stop the frame from bending in the middle. In the case of the six longer frames, a system of four longitudinal steel trusses were used to brace the frame. Two of the trusses were mounted on top of the side sills, one on each sill. The truss rods, which ran from one end of the frame to the other, were fabricated from ½ inch (12.7 mm) thick 2 inch (51 mm) wide steel bar stock. The ends of the truss rods were rounded and threaded. Each truss rod rested on two short vertical steel bars called "queen posts" which were fastened to the side sills at the locations where the bolsters would be placed. The ends of the truss rods were bent down so that they passed through holes drilled at an angle through the end sills. By tightening nuts placed on the ends of the truss rods, the side sills were partially braced and were prevented from being bowed upwards by heavy weights in the vestibules. (Ottawa Car Co. Specifications for Streetcars, August 1, 1908, p. 2, and Cyclopedia of Applied Electricity, Vol. III, 1908, p. 70)

To prevent the frame from sagging, truss rods were also placed beneath the frame. In order to strengthen the intermediate sills as well, two 6 inch (152 mm) high steel "I" beams, which were called truss beams or needle beams, were placed across the frame approximately 2 feet (610 mm) on either side of the middle of the frame and were secured to the sills by bolts. Iron castings approximately 1 foot (305 mm) in length were placed on each end of the "I" beams. These castings comprised the queen posts for the bottom truss rods. The rods themselves

were fabricated from 1 1/8 inch (27 mm) diameter steel rod. Unlike the upper truss rods, however, the lower rods were flattened at the ends and were bolted to the side sills immediately below the upper truss queen posts. The bottom truss rods were also cut in the middle and each half threaded so that they could be joined by a turnbuckle. The turnbuckle enabled the tension on the lower truss rods to be easily adjusted. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 2)

The frame for the shorter streetcar also had two upper trusses. The lower trusses were omitted because the frame was to be placed on a single truck which was designed to support the side and the intermediate sills. (Ottawa Car Co. Specifications for Streetcars, July 31, 1908, p. 2)

The fabrication and the installation of the vestibule platforms was the next step of construction. Each vestibule was to be 4 feet 8 inches (1 422 mm) long and was designed to have one semi-circular end. A frame for the vestibules, containing two 7 foot (2 134 mm) long oak sills called "knees", were secured to the body frames' intermediate sills by long steel bolts. Additional shorter knees were secured to the end sills of the body frame also with long bolts. In order to prevent the vestibule from sagging, specially shaped steel plates were bolted to the sides of each knee and to the sills on the body frame. (Ottawa Car Co. Specifications for Streetcars, July 31, 1908, p. 2, and August 1, 1908, p. 3) The ends of the vestibules not attached to the car frames consisted of a semi-circular shaped piece of white oak, called the crown piece, which was bolted to the knees. Six inch (152 mm) wide steel channel, which was shaped to match the curvature of the crown pieces, was then attached to the knees. This channel, known as a bunter, protected the

vestibules from damage should the streetcar strike or be struck by another vehicle. The frame was then painted with a white lead compound and the sides and the roof were then constructed.

The sides of the body were first constructed. The six longer streetcars had sides that were framed for ten double-sash windows. The upper portion of each sash was to be small and was to be fixed in position, while the lower portion of the sash was designed to drop into a pocket located between the interior wainscoating and the exterior sheathing. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 3) The smaller streetcar was framed for eight double-sash windows. (Ottawa Car Co. Specifications of Streetcars, July 31, 1908, p. 3) Each post for the sides were made from white ash. The posts were secured to the side sills by means of pieces of band iron which were held to the posts and the sills with screws and lag bolts. The tops of the posts, which were tenoned, fitted into a mortised white ash sill that was placed on top of the posts and which formed the support for the roof. Belt rails, which provided the sills for the windows, were gained into the posts on each side and were secured with screws. Each belt rail was formed from a single piece of Georgia pine. This was done to prevent water from entering the interior of the sides. Wood braces were then installed diagonally between the belt rails and the body sills. On each side of the car body, at floor level, an 11 inch (279 mm) wide, 1 3/4 inch (44.5 mm) thick British Columbia fir plank was gained into the sides of the posts facing the interior of the car. These planks, called truss planks, provided extra support for the bottoms of the posts. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, pp. 4-5) The exterior of the car bodies were sheathed with narrow whitewood strips that were placed vertically along the sides and which were nailed to the side

framing. Above the windows, a 4 inch (102 mm) high wood strip was placed longitudinally. This strip, called a letter board, finished the exterior of the car between the tops of the windows and the bottom of the roof. The flooring of the cars was tongue and groove pine that was nailed to the frame. Trap doors were placed at locations where crews could easily reach the motors. The centre of the car body floor, however, consisted of a thin piece of hardwood to which was nailed several narrow hardwood strips which were evenly spaced apart and which were the same height as the rest of the flooring. These strips, which ran longitudinally, provided a grooved surface which was designed to prevent passengers from slipping on the flooring if their footwear was wet or icy. The vestibules were constructed in a similar fashion to the car bodies but the vestibules were framed for three windows and for two folding doors. The fronts of the vestibules were sheathed with Number 14 gauge sheet steel. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 2)

Monitor roofs were applied to these streetcars. The roofs followed a convex curve between the letter boards and a raised central section called a "monitor". A monitor was a clerestory which usually ran along the entire length of the car body on both sides. The monitor, because of its similarity in appearance was named after the iron clad ship of the same name which fought in the American Civil War, contained several small windows along the sides and the ends. The monitor also served as a ventilator since the windows along the sides could be opened. The roof was supported by ash rafters and by 3/8 inch (9.5 mm) diameter steel rods called "carlines". Carlines were formed to the shape of the roof and were placed parallel to the rafters. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, pp. 4-5, and Cyclopedia of Applied

Electricity, Vol. III, 1908, p. 71) The top of the monitor was arched slightly and had eaves which extended 6 inches (152 mm) over the sides of the monitor. The roofs were sheathed with thin basswood strips which were covered with a white lead compound. The sheathing was covered with Number 10 weight canvas duck. The canvas was nailed to the tops of the letter boards and was then coated with several layers of paint in order to make it waterproof. The roofs of the vestibules, which were called hoods, arched up from the tops of the vestibules and connected to the roof of the car body. Ash rafters supported the hoods and they were sheathed with basswood strips and covered in canvas. It should be noted that the canvas was usually applied to all sections of the roof at a time. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 5) A wooden framework, which was called a trolley board, was then placed on the roof as support for the trolley pole (current collector). In the case of the longer streetcars, two trolley boards were placed near each end of the monitors. The shorter streetcar required only one trolley board, which was located in the middle of the roof, since the trolley pole would be long enough to be swung around to either end of the car when the direction of travel was to be reversed. (Ottawa Car Co. Specifications of Streetcars, July 31, 1908, p. 6) The interiors of the cars were then finished.

The wainscoating, bulkheads, doors and sashes were all fabricated from Ontario cherry. An additional set of body windows, called storm sashes, were supplied. These storm sashes were designed to be installed on the streetcar's exterior in the winter months in order to reduce heat loss and drafts into the interiors. The interiors of the sashes were covered by roller blinds that were mounted above the sashes. In the vestibules, the bulkhead windows were protected from accidental blows

by an arrangement of three brass tubes which were placed horizontally across the sashes near the bottoms. The interiors of the vestibules were finished with cheaper birch wood which was stained to resemble cherry. The ceilings of the car body and the vestibule consisted of a three-ply wood veneer which was finished to resemble bird's-eye maple. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, pp. 1-6) Before the interiors were completed, however, the cars were wired for interior incandescent lamps, incandescent headlights and electric heaters. In addition, large diameter wires were strung between the trolley boards and the bottoms of the frames via diagonal corners of the body interior. All the wires that were used consisted of a solid copper conductor which was insulated by a rubber coating. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 7) The interior electric lamps were suspended from fixed sockets which were located in the ceiling. The sockets held clusters of two or three lamps each. Each lamp circuit contained five 110 volt, 40 W incandescent bulbs which were connected in series. It should be remembered that the trolley wire voltage was, ideally, 550 volts. It was, therefore, necessary to use series circuits if ordinary and inexpensive household bulbs were to be used instead of costly high-voltage bulbs. The headlights, one mounted on each end of the streetcar, consisted of a cylindrical iron casting which was secured to the sheet steel sheathing. A mirrored concave glass reflector was placed inside the casting as well as a socket for an incandescent bulb. The bulb and the reflector were protected by a hinged cover which held a glass lens. Wherever possible, the wiring was concealed behind moldings that were easily removeable. (Ottawa Car Co. Specifications of Streetcars, p. 7, and Railway and Marine World, November 1908, p. 315)

The electric heaters that were installed consisted of a number of

hollow porcelain tubes on which were wrapped coils of spirally-wound resistance wire. When trolley voltage was applied to the heaters, the wire would produce large amounts of heat. The heaters were housed in perforated metal boxes in order for natural air flow to distribute the heat. (Doane & Parkham, 1926, § 22 pp. 28-29) A total of fourteen cross-seat heaters were installed in each of the six longer streetcars. These heaters were mounted on the floor directly under the seats. Ten cross-seat heaters were installed on the shorter streetcar. (Ottawa Car Co. Contract for Streetcars, September 3, 1908, pp. 2-3)

Before the seats were installed, the interiors were sanded and varnished. In addition, a cord was strung along the entire length of each interior. Each end of the cord, which passed through holes drilled through the tops of the bulkheads, was connected to a small hammer gong assembly that was mounted on the ceiling of each vestibule. These gongs, usually about 4 inches (102 mm) in diameter and which were of brass or bronze castings, were rung each time the cord was pulled. (Artifacts and Photographs in Author's Collection) In this manner, passengers could signal the motorman or the conductor when they wished the streetcar to stop. The manufacturer's name as well as the car number were then painted in gold letters on the car body panels above the bulkhead doors.

The seats that were installed on the first ERR streetcars were of the cross-seat, reversible type. The term "cross-seat" meant that the seats were mounted across the interior of the car. A reversible seat employed a cast iron frame and a moveable seat cushion and seat back. The seat cushion and seat back could be moved by means of a brass handle on the seat back so that the seat could face the direction of streetcar travel. The seat backs and cushions were upholstered with woven rattan strips, sometimes referred to as "cane" or "wicker". The

seat backs were stuffed with horsehair while the cushions contained an array of spiral springs. A total of twenty cross-seats were installed in each of the long streetcars. Sixteen were installed in the shorter streetcar. With the exception of the four seats in each corner, the reversible seats were arranged so that they were placed against the sides of the body but beneath the centre of a window. This arrangement created an aisle down the centre of the car body. The four corner seats were not reversible and they were attached to the walls. Each seat cushion was approximately 34 inches (864 mm) wide and could accommodate two passengers. The six longer streetcars, therefore, could seat forty passengers while the shorter streetcar could seat only thirty-two passengers. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 2 & p. 6, and July 31, 1908, p. 5)

A 12 inch (305 mm) diameter steel gong was placed beneath the floor of each vestibule. A steel plunger, which passed through the floor, could push a weighted hammer which struck the gong. The gong was to be used for warning pedestrians and motorists as well as for signalling. Two gravity-feed sanders were also installed on each streetcar. Each sander, which consisted of a wooden bin located underneath the fixed corner seat to the left of the motorman, was designed to deposit a quantity of sand on the left-hand rail immediately in front of the wheel when the motorman pushed a foot plunger. This plunger moved a series of rods and levers which opened a hatch at the bottom of the sand bin. Sand would fall from the bin and would be guided to the rail by a short length of pipe. The sand improved the adhesion of the wheel against the rail. (Ottawa Car Co. Contract for Streetcars, September 3, 1908, pp. 1-2) The streetcar was now ready to be placed onto trucks.

The car bodies, in order to travel along the rails, had to be mounted

onto one or more sets of wheels called "trucks". Doane and Parkham (1926) define a truck as "a set of wheels in a framework designed to support the whole or part of the weight of a car body and equipment" (§ 22 p. 49). Two general types of trucks could be used on streetcars, single or rigid trucks, or swivel trucks. A single truck consisted of a steel framework that was rigidly attached to the car body frame which also held two axles a certain distance apart. Swivel trucks, usually mounted in pairs, consisted of a steel framework that held the two axles a certain distance apart. The entire truck framework, however, was designed to swivel beneath the car body on a fixed point. In this way, long streetcars could negotiate sharp curves. Single trucks were rarely used on streetcars with body lengths greater than 22 feet (6 706 mm) because the wheel base (distance between the axles) required to support properly longer streetcars would not allow the truck to negotiate tight curves. (Doane & Parkham, § 22 p. 47) It is for this reason that only the shorter streetcar was equipped with a single truck. It is important to note that this streetcar, ERR Number 7, was the only single truck passenger streetcar that was operated on the system (see Appendix I).

Most Canadian streetcar builders did not have the equipment that was necessary to manufacture streetcar trucks. Trucks were purchased from either large American streetcar builders or from steel foundries. The Ottawa Car Company, at that time, generally purchased trucks from the J. G. Brill Company of Philadelphia, Pennsylvania. Brill was a large American streetcar builder.

It was mentioned previously that the six longer streetcars had provision for two bolsters under the body frame. Bolsters were necessary for placing the car body on the swivel trucks. The bolsters used for these streetcars were fabricated from two heavy steel plates, each

9 inches (229 mm) in width. One plate, 3/4 inches (19 mm) thick which extended across the middle of the body frame, was flat and was bolted to the frame. The second plate, 7/8 inches (22.5 mm) thick, which was bent downwards in the middle, was bolted to the first plate at the ends. Small steel blocks kept the two plates a set distance apart. The central portion of the second plate was shaped so that it lay parallel to the first plate. This type of bolster was known as a "diamond pattern" bolster. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 2) A forged steel bearing plate, which was called a centre-plate, was bolted to the centre of the lower bolster plate with four large bolts. The centre-plate was formed so that it held, vertically, a length of 1 3/4 inch (44.5 mm) diameter hardened steel rod which was called a "kingpin". The kingpins were approximately 6 to 10 inches (152 to 254 mm) in length and were designed to fit into corresponding holes in centre-plates which were bolted to the centre of each truck. The kingpin and centre-plate assembly held the truck in position on the bolster while allowing the truck to swivel without damaging the bolster or the underside of the car body. (ERR Drawings of Centre-Plate Assemblies) Additional bearing plates were located on the bolsters to either side of the kingpin. These bearing plates prevented the car body from rocking sideways a great distance. (ERR Drawings of Side Bearing Plates)

The trucks that were selected for these streetcars were Brill type 27-G-1 with a 4 foot 6 inch (1 372 mm) wheelbase. (Ottawa Car Co. Contract for Streetcars, September 3, 1908, p. 2) The normal wheelbase of a 27-G-1 truck was only 4 feet (1 129 mm). Longer than normal sideframes, therefore, were required to extend the trucks' wheelbase. The designation of the longer wheelbase Brill trucks was 27-GE-1. (Brill Drawings and Specifications of 27-G-1 and 27-GE-1 trucks, and Brill

Photograph 4800, showing a 27-GE-1 truck for the ERR) The steel sideframes held the axles in position. The axles, to which the wheels were pressed, rested against brass bearing plates which were held in moveable cast iron cases called journal boxes. The bearings were lubricated by filling the lower portion of the journal box with oil and with a cotton fibre wick called "waste". The wheels that were applied to the first ERR streetcars were 33 inch (838 mm) diameter cast iron. (CECR No. 143, December 28, 1909) The wheels were cast so that the rim was supported by six evenly-spaced spokes. The wheels were turned on a metal lathe so that the flanges and edges of the wheel were concentric. The sideframes did not rest on the journal boxes directly. Four coiled springs were placed between the top of each journal box and pockets in the sideframes. Additional coil and leaf springs separated the sideframes from the truck bolsters. A truck bolster was a steel beam on which the streetcar rested. The springs were so arranged that each wheel could undulate vertically without affecting the vertical motion of the other wheels. In addition, the springs absorbed much of the bumping of the wheels along the rail surface, thus providing a smoother ride for the passengers. The sideframes were held at the correct distance apart by shaped steel angle bars which were bolted across the ends of each sideframe. These angle bars, through an arrangement of coiled springs, supported a vertically aligned flat steel bar that was designed to allow an electric motor to be bolted to it. Each truck, therefore, could support two motors. The motors had to be placed near the ends of the truck since there was insufficient room for them between the axles and the truck bolster. This motor placement was referred to as "outside-hung". (Brill Co. Specifications of 27-GE-1 Truck)

There was a disadvantage to trucks with outside-hung motors. If

the speed of the streetcar was to exceed 30 miles per hour (48.3 km/h), the trucks would tend to oscillate vertically. If a great enough speed was achieved or if the track was in poor alignment, the trucks would derail. Most streetcars in urban service would rarely travel at speeds greater than 30 miles per hour (48.3 km/h) so most short wheelbase streetcar trucks used outside suspension. (Brill Co. Specifications of 27-GE-1 Truck) The Ottawa Car Company did not supply the electric motors for these ERR streetcars so the trucks were installed without motors. (Ottawa Car Co. Contract for Streetcars, September 3, 1908, p. 2)

The shorter streetcar (Number 7) was equipped with one Brill 21-E single truck which had a wheelbase of 8 feet (2 438 mm). (Ottawa Car Co. Specifications of Streetcar, July 31, 1908, p. 1) The sideframes of the 21-E truck not only supported the journal boxes but, through a series of coiled and leaf springs, they supported long steel bars on each side that were bolted to the side sills of the car body. The weight of the car body was transferred to the truck through the side sills. The truck, which was securely cross-braced with steel bars, prevented the car body from sagging in the middle. The long wheelbase of the 21-E truck enabled the hanger bars (yokes) for the motors to be placed between the axles. The motors, therefore, were inside hung. The inside suspension of the motors contributed to the stability of the streetcar. An additional feature of the 21-E truck that was not found on the 27-GE-1 truck was a lifeguard (sometimes called a fender) at each end of the truck. A lifeguard was a device that prevented a large object, specifically a human being, from being run over by the wheels. The lifeguards on the 21-E truck consisted of two steel castings that were bolted to the sides of the sideframes at each end of the truck. A large

board was then bolted across the ends of the castings. The board, which was placed so that it was only a few inches (mm) above the level of the tracks, prevented large objects from being run over since such objects tended to be pushed along by the board. (Brill Co. Specifications of 21-E truck, 1908) A different type of lifeguard was used on streetcars which had swivel trucks. It will be discussed later in this section.

Following the installation of the trucks, the streetcars were fitted with handbrakes. These brakes were to be the streetcars' main braking system. Although air brakes were being used on other street railways, they were expensive and were thought not to be necessary for the ERR. The single truck car, in addition, had no room beneath it for air brake apparatus. The handbrake system consisted of chains, rods, levers and winding shafts which exerted tension on brake shoe levers which pulled metal brake shoes against the sides of the wheels. The friction between the wheels and the brake shoes slowed or stopped the streetcar. A large, vertically-mounted shaft was placed in the front of each vestibule. The top of the shaft had a bronze handle which could be rotated in either direction. The handle, by means of a ratchet arrangement, would not turn the shaft when it was rotated counter-clockwise. A large ratchet gear was placed on the shaft immediately above the point where the shaft passed through the vestibule floor. A large pawl lever, which was called a "dog", was bolted to the floor a short distance away. The motorman could, with his foot, hold the dog against the ratchet gear. When this was done, the shaft could rotate in a clockwise direction only, thus applying and holding the brakes in the "on" position. By pushing the dog away from the gear, the motorman would allow the shaft to rotate counter-clockwise, releasing the brakes. A length of chain was bolted to a spiral-shaped casting which was attached to the shaft below the

vestibule floor. The chain, in turn, was attached to a steel bar which was connected to a large steel lever which was bolted to one of the intermediate sills near the centre of the car body. The lever, which pivoted in the middle, was attached to two other steel bars which were connected to the brake rigging of the trucks. When the motorman wound the shaft in a clockwise direction, the chain would wrap around the spiral casting on the shaft. This action would pull the lever. The action of the lever would be transmitted to the brake rigging on the truck. The brake shoes would be pulled against the sides of the wheels with great pressure because of the lever action. The streetcar could, therefore, be slowed or stopped by the actions of one man. (ERR Drawings of Brake Gear, 1908-1910, and Cyclopedia of Applied Electricity, Vol. III, 1908, pp. 53-56) The brake shoes, made of cast iron, conformed to the radius and to the flanges of the wheels. The shoes were designed to be pressed against the sides of the wheels as well as against the sides of the flanges. (ERR Drawings of Brake Shoe Patterns, 1910-1931) Considerable noise was generated by the metal shoes rubbing against the metal wheels when the brakes were applied. Brake shoe noise was a common complaint of some of the citizens against streetcar operation.

Additional external hardware was applied to the streetcars before they were shipped. Steps were attached to the bottom of each vestibule below the doors. A single step was provided. Each step consisted of formed malleable iron hangers and risers. The treads were made from 1 ¼ inch (31.8 mm) thick birch or maple planks which were bolted to the hangers. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 3) The height of the step, measured from the top of the rail, was approximately 16 inches (406 mm). (ERR Specifications of Streetcars, 1913) In order to assist passengers entering the streetcars, vertical grab

handles were placed on either side of the vestibule doors. These handles consisted of 1 1/8 inch (29 mm) diameter white oak or hickory dowels which were about 30 inches (762 mm) in length. Bronze fittings, which were held to the sides of the streetcars with screws, held the dowels vertically and a short distance away from the sides. In addition, at diagonal corners of the body, several small cast iron steps were secured to the posts. These steps enabled ERR personnel to climb onto the roof of the car. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, pp. 6-7)

Below each vestibule floor was attached a spring-buffered draw bar which had a link and pin coupler box. These steel draw bars were fixed to one pivot point on the vestibule's centre knee. A heavy coiled spring connected the draw bar to the pivot point. A steel guide rail which was bolted to the vestibule crown piece held the draw bar horizontal. The exposed end of each draw bar consisted of a steel box which had a vertical hole through it. A steel pin was placed through this hole. The pin held a large steel link which was inserted into the end of the box and which could be connected to another draw bar. By this arrangement, a streetcar could be pulled by another vehicle. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 7)

When all the necessary hardware had been installed, the exterior of the streetcars could be painted and lettered. Several coats of linseed oil primer were first applied. Colored oil-base paints were then brushed onto various parts of the exterior. Although the Contract for these cars does not specify what the colors were, a press report written on the day that the first streetcar arrived in Edmonton stated that they were "green in color, with natural wood trimmings and on each side the words in gold, 'Edmonton Radial Railway'" (Edmonton Bulletin, October

29, 1908, p. 8). The green portions appear to have been the sections of the vestibule and carbody below the belt rails. It is likely that the trucks, underframes and the canvas on the roofs were all painted black.

After two coats of colored paint were applied, the lettering and the numbering was applied to the exteriors. The numbers, which were applied on either side of the name, were also applied to the dash (the front portion of the vestibule) on either side of the headlight. When the lettering was complete, three coats of varnish were applied over the exterior to prevent the paint and lettering from suffering the effects of weather. (Ottawa Car Co. Specifications of Streetcars, August 1, 1908, p. 7) At this juncture, the streetcars could be pushed up an inclined ramp and onto railroad flat cars where they would be secured, covered and then transported to Edmonton. Plate 18 (Public Archives of Canada, PA-137800) shows the external appearance of ERR streetcar Number 2 at the Ottawa Car Company plant in October, 1908 immediately before it was sent to Edmonton. The trucks, truss rods, steps, brake handle, storm sashes, monitor and the trolley boards should all be noted. Plate 19 (Public Archives of Canada, PA-137799) shows the interior appearance of Number 2 after its construction was complete. The reversible cross-seats, monitor sash openers, grooved flooring and the sliding bulkhead door should all be noted. Plate 20 (Public Archives of Canada, PA-137802) shows the external appearance of the single truck streetcar Number 7 at the Ottawa Car Company plant in November before it was sent to Edmonton. The lifeguards, draw bars, grab handles, single trolley board and the wire protruding from the bottom near the right-hand step should all be noted.

Number 2 was the first streetcar to arrive in Edmonton. Although both 1 and 2 left the plant at the same time, each was transported by

Plate 18. (Public Archives of Canada) Streetcar Number 2
At Ottawa Car Company, 1908

Plate 19. (Public Archives of Canada) Interior of Streetcar Number 2
At Ottawa Car Company, 1908

Plate 20. (Public Archives of Canada) Streetcar Number 7
At Ottawa Car Company, 1908

Plate 21. (Public Archives of Canada) Streetcar Number 14
In Preston, Ontario, 1909

a different railroad. The railroad that delivered a streetcar first would obtain a contract for transporting the other five. Number 2, which the CPR had been transporting, arrived in Edmonton on October 24, 1908. (Edmonton Journal, October 20, 1908, p. 1, October 22, 1908, p. 1, and October 24, 1908, p. 4) Number 1, which had been transported by the Canadian Northern Railway, did not arrive in Edmonton until October 31. (Edmonton Journal, October 31, 1908, p. 1) The remaining five streetcars arrived in Edmonton before the end of December (see Appendix I).

Before Number 2 or any of the other streetcars could be placed in service, electric motors and their control apparatus had to be installed. About the same time that the streetcars had been ordered, the City had ordered the necessary motor and control equipment from the Canadian General Electric Company of Peterborough, Ontario. The equipment was to be delivered to Edmonton. Four motors were to be installed on each of the six longer streetcars while two motors were to be installed on streetcar Number 7. The motors that were selected were designated GE-80A-1. These motors had a rating of 40 H.P. (29.8 kW) and were designed for heavy-duty use. (CGE Contract for Motors and Equipment, August 18, 1908) The GE-80A motor consisted of a split cast iron case or frame, the lower half of which could be opened for maintenance purposes. The motor also included a number of field coils which were bolted to the interior of the case. A large armature which was supported by oil-lubricated babbit bearings was also housed in the case. The case was shaped so that one end of it slid onto an axle of a streetcar truck. Babbit metal sleeve bearings which were lubricated from oil reservoirs in the case protected both the axle and the motor case from wear. The other end of the case was bolted to the spring-supported motor

hangers on the truck. Figure 34 (after General Electric Co. Drawing No. 14182, May 1905) shows the plan and end views of a GE-80A motor, outside-mounted on a streetcar truck. Minor deletions and additions were made by the author.

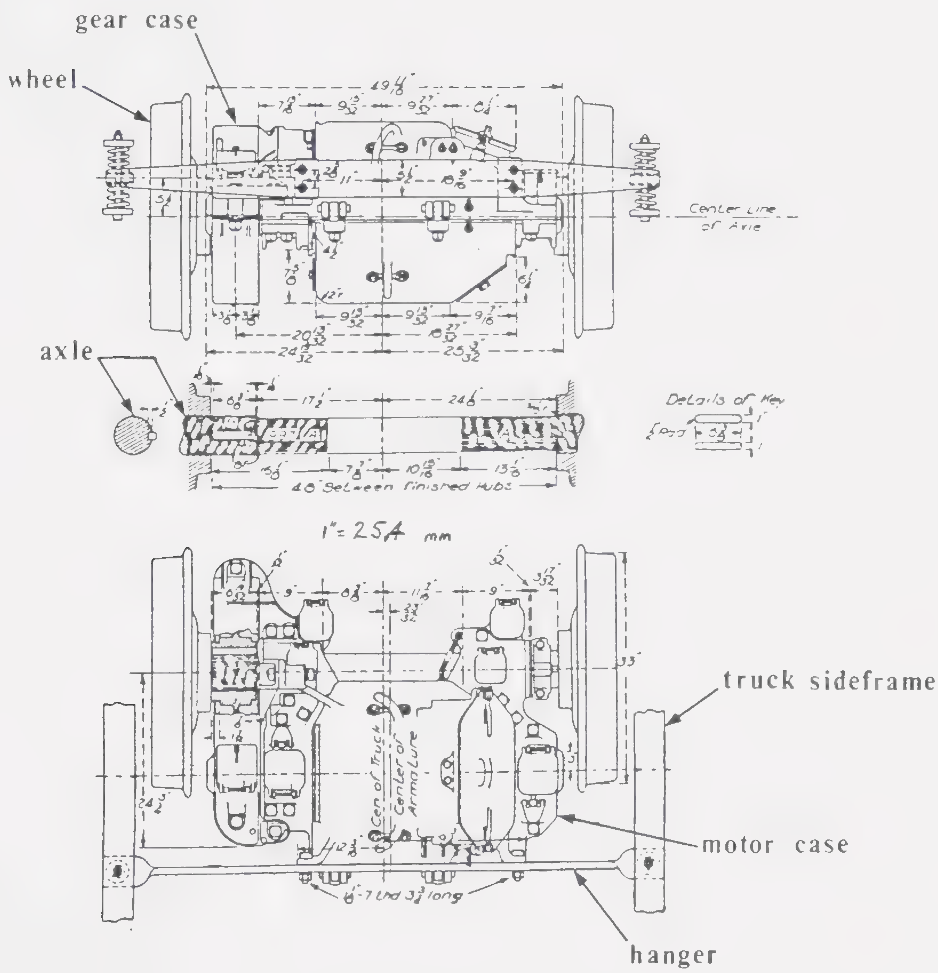


FIGURE 34. OUTSIDE HUNG GE–80A MOTOR, END AND PLAN VIEWS

The torque of the motor was transmitted to the axle through two spur gears. A small diameter pinion gear was pushed onto the end of the motor's armature shaft and was held on by a nut which was placed on the shaft. A rectangular steel key placed in a notch in the gear

and into a corresponding keyway in the armature shaft prevented the gear from rotating independently of the armature. A large diameter gear, which was split in half, was bolted and keyed onto the axle of the truck. A split gear was easier to install, align and remove than a solid gear. Both gears were lubricated with grease and were enclosed in a pressed steel cover. (General Electric Co. Bulletin 4421, January 1907, pp. 5-6) Figure 34 shows the gear cover and axle keyway for a GE-80A motor. The gears, which each had a 5 inch (127 mm) face, were manufactured in a variety of size ratios. The appropriate ratio was selected from a number of tables which plotted motor efficiency against speed and tractive effort for each available ratio. For most urban applications where the maximum speed was unlikely to exceed 30 miles per hour (48.3 km/h), a gear ratio of 69 to 17 was recommended. The pinion gear possessed 17 teeth while the large split gear possessed 69 teeth. General Electric motors that used a gear ratio of 69 to 17 had the suffix 1 added to their designations, hence GE-80A-1. (General Electric Co. Bulletin 4421, January 1907, pp. 6-15) Forty H.P. (29.8 kW) motors were considered to be powerful enough to move the streetcars along the grades found on the ERR in 1908. It should be noted that when the streetcars were in operation, a whine could be heard from the vicinity of the trucks. This noise was caused by the successive meshing of the gear teeth and was a distinctive feature of spur gears.

Power for the motors had to be collected, regulated and controlled on the streetcar. Current was drawn from the trolley wire by means of a trolley wheel. A trolley wheel was usually about 4 inches (102 mm) in diameter and was made of cast phosphor bronze. The wheel was shaped so that a large groove was formed around the circumference in the middle. The wheel was mounted on a small steel axle which was

held in a U-shaped iron casting called a "harp". The harp allowed the trolley wheel to rotate freely on its axle. A short length of steel rod attached to the bottom of the harp enabled it to be inserted into a tapered steel tube called a trolley pole. Trolley poles, which ranged in length from 12 to 14 feet (3 658 to 4 267 mm), were bolted to a steel swivel base that was attached to the trolley board of a streetcar. These swivel bases were known as "trolley bases" and they consisted of three main parts: the fixed base, which was bolted to the trolley board and which held the rest of the assembly; the spring base, which swiveled around a pivot on the fixed base and which held two or four springs; and the foot. The foot, which was attached to the spring base, could pivot up and down. It was also attached to the other end of the springs that were attached to the spring base. The foot also gripped the thick end of the trolley pole. (Doane & Parkham, 1926, § 22 pp. 4-7) The action of the springs caused the trolley pole to be pulled upwards. The trolley wheel, therefore, ran along the underside of the trolley wire. The groove in the trolley wheel kept it from easily slipping off the underside of the wire. A rope attached to the harp enabled the trolley pole to be pulled down. When it was not in use, a steel hook which was attached to the trolley board, held the trolley pole horizontal. The springs on the trolley base could be adjusted so that the pressure of the wheel against the wire would be between 20 and 40 pounds (9 to 18 kg), which was the recommended range for trolley wheel pressure on the wire. The spring trolley bases did not allow a streetcar to travel in both directions without changing the direction of the pole. In normal operation, the pole trailed behind the streetcar. If, however, the streetcar were to travel in the opposite direction, the trolley pole would be leading. The forces acting against the trolley wheel,

when the trolley pole was leading, combined with the pull of the springs, could cause the trolley wheel to snag on special work or on ears. The result would be a bent or broken trolley pole. It is for this reason that double-end streetcars either had a pole at each end or, if the car were short enough, one pole that could be swiveled from one end of the car to the other. (Doane & Parkham, § 22 p. 7)

The current, after travelling through the trolley wheel, harp and base, entered a large copper cable that was connected to the fixed base, and which led into the vestibule of the streetcar at the opposite end to where the pole was located. A smaller wire was connected to the larger cable at the point where the larger cable entered the streetcar. The smaller wire travelled to the bottom of the frame where a lightning arrester was located. The ground wire from the lightning arrester was connected to the case of the nearest motor. The operation of lightning arresters was described in the previous chapter. Immediately before the large cable entered the streetcar's vestibule, the cable was coiled around a large diameter wooden dowel for several turns. These coils, which were referred to as "chokes" or "kicking coils", acted as inductors and tended to prevent extreme current surges such as lightning from travelling through the large cable rather than through the lightning arrester. (Cyclopedia of Applied Electricity, Vol. III, 1908, pp. 41-42) A circuit breaker, or a fuse box in the case of streetcar Number 7, was then placed in the circuit. The circuit breaker or the fuse box was mounted on the interior ceiling of the vestibule. The circuit breakers were occasionally referred to as "hood switches" since the roof of the vestibule was often called a hood. Both units possessed a wooden handle that protruded from the bottom of the cabinet. The handle was attached to a moveable contact that could open (break) the circuit. The circuit

breakers, which functioned in a manner similar to those described in the previous chapter, would allow a maximum of 300 Amperes at 550 volts D.C., or 165 kW of power to pass through the circuit without tripping. The fuse on car Number 7, however, allowed only 150 Amperes at 550 volts D.C., or 82.5 kW of power through the circuit before the fuse element melted and broke the circuit. (CGE Contract for Motors and Equipment, August 18, 1908)

A circuit breaker was installed in each of the vestibules of double-ended streetcars. Circuit breakers were not sufficient to control the power reaching the motors. If full trolley voltage was applied at once to the motors, the extreme and sudden torque could destroy the gears as well as throw the passengers about who were inside the streetcar. Therefore, a device was inserted between the circuit breaker and the motors which controlled the voltage reaching the motors. This device was called a "controller".

A streetcar controller consisted of a cast iron and sheet metal cabinet that was mounted vertically on the floor of the vestibule. The controller stood about 3 feet (914 mm) high and was about 17 inches (432 mm) wide. The top consisted of a brass cover which had two square steel shafts protruding a short distance vertically. The right-hand shaft accepted a small metal handle that was called the reverse handle or key. The shaft to which the key was attached rotated a wooden drum inside the controller that metal contacts on it which controlled the direction that the motor armatures rotated. In addition, a gear attached to the shaft unlocked the left-hand shaft if the key was placed in either the "forward" or "reverse" positions. If the key was between these positions, the other controller shaft could not be moved. By means of a notched flange on the cover, the key could only be removed from the

shaft if it was between the forward and reverse positions. In this manner, the controller could not be operated unless the key was present. The other shaft accepted a large brass handle that was called the power handle. The power handle rotated a large cast iron shaft inside the controller that engaged various contacts which controlled the voltage that reached the motors. (CGE Drawing of K-6 Controller, December 1909) Such manually operated controllers, which controlled the voltage reaching the electrical circuits of the motors and their direction of rotation, usually had the designation "K". There were many different types of K controllers, each designed for a specific application. On streetcars that had four motors, a K-6 controller could be used. Two motor streetcars could use a K-10 controller. (Cyclopedia of Electricity, Vol. III, 1908, pp. 17-24)

The writing and the functioning of a controller was complicated. Type K controllers were sometimes referred to as "series-parallel" controllers. For part of the time that the controller was on, the motors would be arranged in a series or a series-parallel circuit (depending upon whether the streetcar possessed two or four motors). All motors would be arranged in a parallel circuit when the controller was advanced to the higher voltage positions. The transition from a series or a series-parallel circuit to a parallel circuit provided a wide range of motor speeds. The K-6 controller, the most common type on the ERR which was designed to operate four motors, possessed eleven acceleration steps or notches. As the motorman rotated the power handle clockwise, a gear with eleven teeth would also be moved. This gear engaged a spring-loaded roller which prevented the power handle from resting between notches. Each clockwise movement of the power handle moved copper rings that were mounted on the power shaft into contact with stationary copper "fingers".

These fingers, which were held against the rings by springs, completed circuits between the controller and the motor circuits. The first five notches of the controller were labelled series-parallel since the motors were arranged in a series-parallel circuit in those notches. In addition, large cast iron resistance grids called "rheostats" were placed in series with the motors in four of the five notches. Rheostats, which were held in open steel frames that were insulated from the rest of the street-car, were mounted underneath the streetcar so that they would be exposed to air for cooling while being protected from water. The rheostats were arranged in three groups according to their resistance values. When the power handle was moved to the first notch, all of the rheostats were placed in series with the motor circuits. The resistance of the rheostats dissipated much of the trolley voltage as heat so the voltage reaching the motors was quite low. As the power handle was moved to higher notches, portions of the rheostats would be shorted out by the controller so higher voltages would reach the motors. When the sixth notch was reached, all the resistance in the circuit was shorted out and the streetcar could run in this position indefinitely. This could not be done with the five previous notches since the heat produced by the rheostats over a long period was sufficient to melt them. At the sixth notch, sometimes called "full series", the streetcar's motors were receiving approximately half power. (Cyclopedia of Applied Electricity, Vol. III, 1908, pp. 17-18, and Doane & Parkham, 1926, § 22 pp. 15-16)

In the seventh notch, referred to as "transition", the controller would place half the resistance back into the circuit while simultaneously changing the connections of the motors from series-parallel to parallel. In the next three steps, the controller would short out portions of the rheostats. In the eleventh notch, each of the motors would be receiving

full voltage. In this position, the motors would attain great speed. Figure 35 (after Cyclopedia of Applied Electricity, Vol. III, 1908, p. 18, and Harding & Ewing, 1926, p. 358) shows schematically the eleven steps of operation of a K-6 controller. It should be noted that the operation of a K-10 controller was similar but only two motors were used with it. (CGE Wiring Diagram for K-10 Controller)

In order for the streetcar to back up, the motorman had to place the power handle in the "off" position and place the key in the "reverse" position. The wooden drum inside the controller that was connected to the key engaged copper contacts which changed the polarity of the motor armatures in relation to the polarity of the field coils. Most street railway motors were classified as being "series wound". This meant that the current flowing through the armature would then pass through the field coils. In normal operation, the magnetic field produced by the field coils would cause the armature to rotate in a particular direction. If the polarity of the armature were reversed in relaltion to the field coils, the magnetic field of the coils would cause the armature to rotate in the opposite direction. (Cyclopedia of Applied Electricity, Vol. III, pp. 23-24) This method of reversal was also useful as a safety feature. If for any reason a streetcar lost its braking capability, it was possible for the motorman, while the streetcar was moving, to place the controller's power hande in the "off" position, move the key to "reverse", and reapply power a notch at a time. The action of the magnetic fields within the motors would tend to slow or stop the rotation of the armatures. It should be noted that this maneuver was intended for emergency use only since tremendous stresses were placed on the armatures and the gears. (Harding & Ewing, 1926, p. 158, and ERR Rules and Regulations, 1914, p. 21) Controller reversal should not be confused

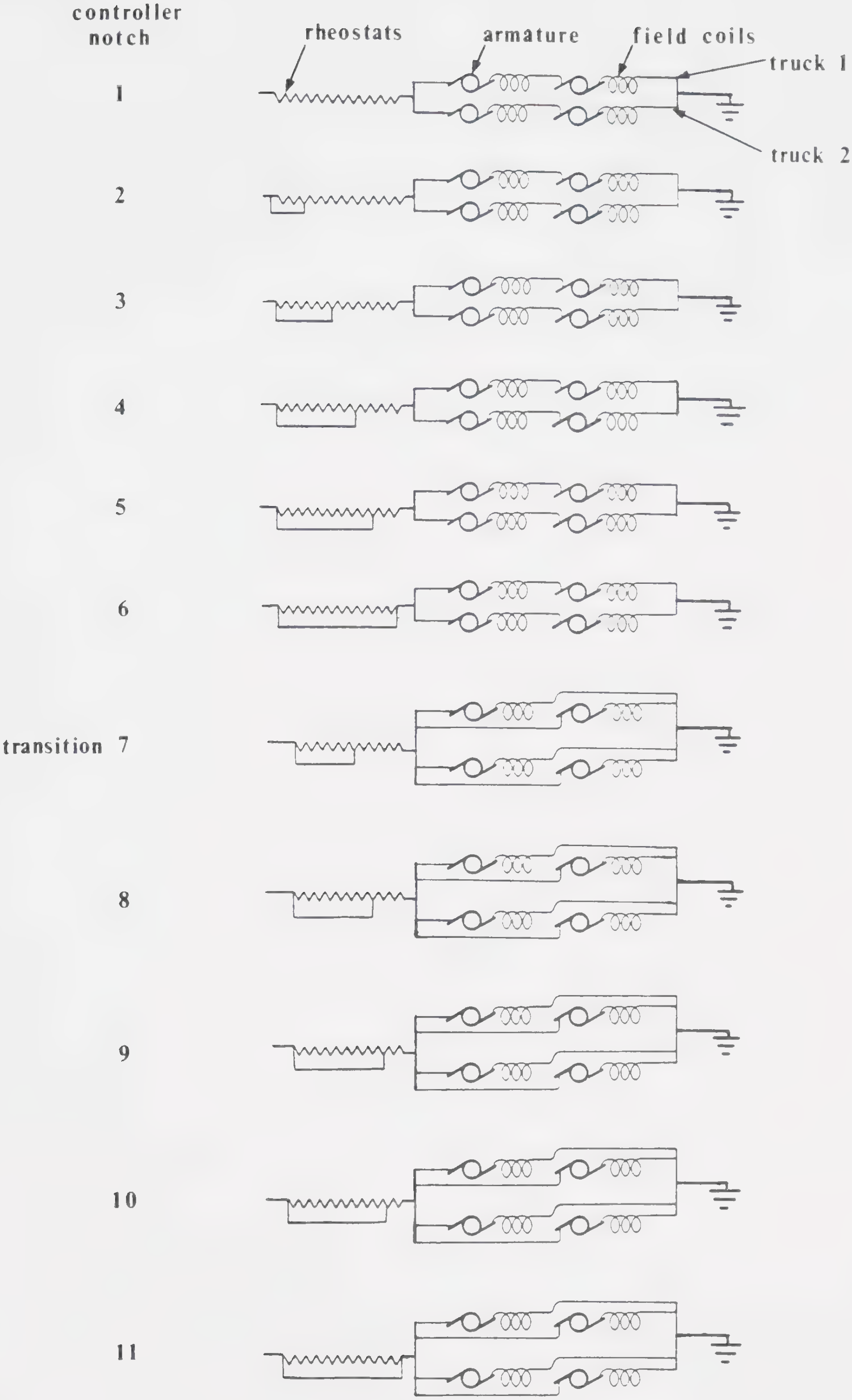


FIGURE 35. SCHEMATIC OPERATION OF A K–6 CONTROLLER

with the reversing of the direction of travel of a double-end streetcar. When a double-end car reached a terminus, the motorman: set the brakes, opened the circuit breaker at that end, removed both controller handles, lowered the trolley pole then in use, raised the trolley pole at the opposite end (with a short car, a single pole would be swung around from one end of the car to the other), placed the controller handles on the controller at the opposite end of the car to where they had been located previously, and closed the circuit breaker at that end. The streetcar could then proceed.

The K-6 controller contained two knife switches inside the controller cabinet. These switches could isolate the motors on each truck. This feature was extremely useful if one of the two motors on a truck failed. By isolating the affected motor, the streetcar could continue without impeding the other streetcars on that track. (CGE Wiring Diagram for K-6 Controller) Although the K type of controller enabled the speed of the motors to be controlled, the system was inefficient and rough. Each time that the motorman advanced the power handle, the streetcar would lurch because of the sudden change of applied voltage to the motors. In addition, all the time that the rheostats were being used was time that current was being wasted as heat. It was to be many years before a more efficient system of control was developed and used in Edmonton.

When the installation of the electrical equipment was complete, the ERR streetcars were then fitted with lifeguards that were mounted on the front of the vestibules. These lifeguards, called fenders, consisted of a framework of steel tubes that supported a web of leather and canvas straps. If a pedestrian happened to fall directly in front of a moving streetcar, the fender was designed to scoop the pedestrian off the ground,

thus preventing the pedestrian from being run over. (Photographs in City of Edmonton Archives) When all of the necessary hardware had been installed, the streetcars were placed in service.

The total weight of each of the six double truck streetcars based upon body weight, truck weight and electrical equipment weight was approximately 40,000 pounds (18 144 kg). Although most of the body construction consisted of wood, these streetcars had a considerable mass. One can, therefore, better understand why such substantial track installations were required to support these streetcars.

Freight and Service Equipment, 1908

It has been mentioned in a previous chapter that the movement of freight was an early concern of the ERR. (See Chapter III) In addition, the winters in Edmonton usually produced copious amounts of snow. In order for the streetcars to be able to operate, a device was necessary that would clear the snow away from the area of the tracks. A vehicle which combined freight hauling capabilities with snow removal would be ideal for the ERR. The McGuire-Cummings Manufacturing Company of Paris and Chicago, Illinois produced a steel-framed combination baggage car and double-end sweeper that met the ERR's requirements. Although many of the passenger streetcars had brushes fitted to the front of their trucks to clear snow away, a heavy snowfall would be too much for the brushes and service could be disrupted. The ERR, therefore, ordered one double end combination baggage and sweeper from McGuire-Cummings before the end of 1908. (CEAR, 1908, p. 81, and McGuire-Cummings Co. Specifications and Drawings of MCB 10-A Truck, October 1908)

The unit consisted of a steel frame approximately 40 feet (12 192 mm) long in which the side, end and intermediate sills were riveted

together. (McGuire-Cummings Advertisement in Electric Railway Journal, 1911, reprinted in Traction Heritage, January 1969, pp. 48-49) The sweeper arrangement at each end consisted of a steel support arm bolted to the frame which extended in front of the ends of the unit at a 45° angle for a distance of approximately 5 feet (1 524 mm). A rod attached to the end of the steel support and to the roof of the car prevented the arm from bending at the end. The arm held two vertically slotted castings at the ends and a similar casting in the centre. A narrow steel axle was placed in the slotted castings. The axle had a sprocket attached to it at one end, chains at both ends and several wooden blocks that contained long strips of rattan. The sprocket transmitted power from the broom motor to the axle. The chains, which were attached to winding shafts inside the body, raised and lowered the axle in the slotted castings. The blocks with the rattan strips comprised the sweeper's brooms. On either side of the car, in the centre, a long flat steel blade that was hinged on one end was attached to the bottom of the frame. A chain attached to the free end of the blade enabled the operators to swing the blade out to the side of the unit. The blades were designed to push accumulations of snow away from the track area. (Photographs in the Author's Collection, and Edmonton Journal, April 15, 1909, p. 8)

The body of the baggage/sweeper was of wood construction. Each side contained six small windows that could be opened, as well as a large sliding baggage door in the middle. The ends of the car were semi-circular in shape and contained three windows each. A small swing door was located at two diagonal corners of the body. The baggage doors enabled freight and the broom motors to be replaced and removed, while the smaller doors enabled crews to enter and leave the body. A plain canvas covered arch roof without a monitor was applied to the car.

The unit travelled on two freight trucks that were manufactured by McGuire-Cummings. They carried the designation MCB 10-A. The "MCB" stood for the Master Car Builders which was an association of various railroads and manufacturers that produced design standards for various pieces of rolling stock hardware and equipment. The 10-A truck conformed to the MCB's specifications. Unlike the Brill trucks described previously, the 10-A trucks did not have extensive springing. Hand brakes similar to those described earlier in this chapter were applied to the unit before it was transported to Edmonton. (McGuire-Cummings Co. Specifications for MCB 10-A Truck, October 1908)

Four GE-80A-1 motors (two on each truck) were installed on the unit after it had arrived in Edmonton. Two additional GE-80A motors were installed in the body of the unit. These motors rotated the rattan brooms by means of chains and sprockets. While K-6 controllers were used for the truck motors, smaller controllers were used to regulate the speed of the broom motors. The smaller controllers simply adjusted the amount of resistance in series with the broom motors. (Canadian General Electric Co. Contract for Motors and Equipment, February 1909) A roof mounted incandescent headlight at each end as well as a large brass swing bell were installed on the unit before it entered service. The bell was mounted in the middle of the roof and was similar in size and construction to the bells found on many steam locomotives of that era. During the summer months when the sweeper equipment was not required, the broom arms and the motors were removed from the unit and the car was used for freight purposes. (Edmonton Journal, May 18, 1909, p. 8) Plate 9 (Glenbow Archives) shows the combination baggage car and sweeper on Ross Road, Strathcona during the summer of 1913. The bell on the roof should be noted.

Passenger Equipment, 1909

Before the end of November 1908, it was apparent to the City officials that ridership on the ERR was far in excess of what was predicted. The Superintendent of the ERR, C. E. Taylor, stated in the 1908 Annual Report, "The indications are that the present passenger equipment will have to be doubled in the next few months" (p. 81) On December 1, 1908, the City Council authorized the ERR to call for tenders for four passenger streetcars. (Edmonton Journal, December 2, 1908, p. 1 and p. 3) Although the streetcars were to be similar in basic shape and construction to those already in service, Superintendent Taylor prepared a list of modifications that the new streetcars would have. These modifications were based upon his observations of the streetcars in operation. (Edmonton Journal, November 19, 1908, p. 8) By December 23, a contract for the four streetcars had been made with the Preston Car and Coach Company of Preston (now Cambridge), Ontario. This Company, in addition to the Ottawa Car Company and the St. Louis Car Company (St. Louis, Missouri), submitted bids for the construction of these streetcars. The Preston Car and Coach Company was selected to build the streetcars because it quoted the lowest price of all the bidders. (Edmonton Journal, December 23, 1908, p. 2)

The basic frame, body and vestibule construction was the same as that used for the first seven streetcars. Several modifications were made, however. The vestibules of the first seven streetcars were 4 feet (1 219 mm) in length. Passengers usually remained in the vestibules only to enter the car body or to step off the streetcar. Fare collection on this type of streetcar was accomplished by a conductor who walked the length of the streetcar at frequent intervals with a portable farebox.

Passengers would pay their fares as the conductor passed. Some passengers could avoid paying their fares by either loitering in the vestibules or by leaving the streetcar before the conductor reached them. A fare collection system where a passenger paid the fare before being able to enter the streetcar body was thought to eliminate most free riders. Such a system had been developed in Montreal in 1905 and was called the "Pay As You Enter" or "PAYE" system. (Railway and Marine World, March 1911, p. 246) Streetcars that were equipped with this method of fare collection possessed longer vestibules in order to contain double folding doors. Passengers would enter the streetcar through the left-hand door in the rear vestibule. A system of railings and stanchions inside the vestibule guided the passengers past a conductor and a farebox which was attached to the vestibule floor. After paying the fare, the passenger could then proceed into the streetcar body through a sliding door in the left side of the bulkhead. A swing door on the right side of the bulkhead, which was isolated by stanchions and railings, enabled passengers to leave the streetcar. In addition, passengers could leave the streetcar by a small door in the front vestibule. In order to enable the PAYE system to operate in either direction of travel, double folding doors were so arranged that no matter which direction the streetcar was travelling, the double doors would be located on the right-hand side of the car on the rear vestibule. The right-hand door of the front vestibule was a single-width sliding door. (Railway and Marine World, February 1909, p. 159, and Plate 21) The length of the vestibules on these PAYE cars was 6 feet (1 829 mm). (Edmonton Journal, December 23, 1908, p. 2) In order to facilitate the use of doors at the sides of the bulkheads, the corner seats were aligned longitudinally with the car body. This arrangement gave the streetcar a seating capacity of forty passengers.

(Preston Car & Coach Floor Plan of Streetcars, 1909) The interior finish of these streetcars, unlike the first seven streetcars, consisted entirely of stained birch. (Railway and Marine World, February 1909, p. 159) The use of birch instead of cherry contributed to the comparatively low cost of these streetcars. The interior lighting arrangement of these cars was also improved. Instead of clusters of bulbs along the monitor ceiling, three longitudinal strings of individual bulbs were installed. A string was located directly beneath the monitor sashes along each side of the car while the third string was located along the centre of the monitor ceiling. (Letter to the Ottawa Car Company from the City Commissioners, November 9, 1910, p. 3) The ends of the monitors of the new streetcars did not end abruptly but sloped down from the ends of the car body to the fronts of the vestibules. A monitor of this type was known as having "Bullnose ends" because of the resemblance to the rounded noses of cattle. (Railway and Marine World, February 1909, p. 159) The bullnose ends prevented snow from accumulating on the hoods. On streetcars with straight-end monitors, snow could accumulate on the hoods directly in front of the monitor. A new design of step was also introduced.

A major disadvantage of the single fixed step was that it allowed individuals to attempt boarding the streetcar from either side of the vestibule at any time. If a person were to attempt boarding a streetcar on the wrong side in an area of centre-pole construction, he or she could be struck by one or more of the poles if the streetcar began to move before the person was safely inside the vestibule. At least one accident of this type occurred on the ERR in 1908. Although the individual was not killed in this instance, he was injured severely. (Edmonton Journal, November 7, 1908, p. 1) In an attempt to prevent this type of accident

from occurring again, the ERR specified that a sliding step arrangement similar to that used on streetcars in Buffalo, New York be installed. (Plate 21, and Ottawa Car Company Specifications for Streetcars, November 1, 1909, p. 1) The sliding steps were controlled by a lever handle inside the vestibule and were designed so that the step riser would be exposed on one side of the vestibule at a time. The step on the other side of the vestibule would not provide a riser so that passengers could not board or alight from that side of the vestibule. In addition to the sliding steps, the cars were equipped with three small tubes which were mounted along the entire body length of each side near the bottom of the windows. (See Plate 21) These tubes were designed to prevent passengers from sticking their heads or arms out of the windows. Such action could enable the protruding limb to be struck by either a passing vehicle or by an adjacent pole. The tubes were a safety feature that was not installed on the first seven streetcars.

The Preston Car and Coach Company, unlike the Ottawa Car Company, obtained their trucks from the Bemis Car Truck Company of Springfield, Massachusetts. Bemis short wheelbase trucks, type 45, were selected for the four ERR streetcars. While the wheelbase of the Bemis trucks was the same as the Brill 27-GE-1 truck, their appearances were markedly dissimilar. The Bemis trucks had heavier sideframes than the Brill trucks. In addition, the Bemis trucks did not use as many springs as the Brill trucks. (Bemis Car Truck Company Drawing of Number 45 Motor Truck) To assist with the clearing of snow and debris from the track flangeways, each truck was fitted with two steel bristle track brushes. The brushes were placed on the end of the truck that faced the vestibule. (See Plate 21)

The exteriors of the cars were finished in a similar manner to

the first seven streetcars except that additional colors were used. The paints were to be supplied by the W. Harland and Son Paint Company. Harland's Coach Painters dark green was applied to the areas of the streetcar below the belt rails while Harland's Birmingham red was applied between the belt rails and the roof. Black was applied to the underframe and the trucks while white was applied to the roofs. (Edmonton Journal, June 29, 1909, p. 8, and Ottawa Car Company Specifications of Streetcars, November 1909, p. 7, and Plate 21) Harland's Coach Painters dark green resembled Pantone ink color 554C while the Birmingham red resembled Pantone ink color 188C. (Color fragments in Author's Collection, and Pantone Matching System Book, 1980) The lettering on the four Preston cars included the City Crest and the car numbers on the sides as well as the numbers on the dashes. The four Preston cars were numbered 10, 12, 14 and 16. This numbering system appears to have been selected as a means of distinguishing Preston built PAYE cars from Ottawa Car Company PAYE cars and from the earlier type of Ottawa car. (Letter to the City Commissioners from ERR Superintendent C. E. Taylor, March 18, 1910) The electrical equipment, supplied by Canadian General Electric, was installed on these streetcars before they were sent to Edmonton. (Railway and Marine World, February 1909, p. 159, and Plate 21) Plate 21 (Public Archives of Canada, PA-137801) shows the appearance of streetcar Number 14 in Preston, Ontario before it was sent to Edmonton in July 1909. The following should be noted: Bemis trucks, track brooms, the three rheostat banks located between the trucks, double-width doors on the rear vestibule, bulkhead doors, lever inside rear vestibule for shifting the rear sliding step, window guards, bullnose monitor ends, and the trolley bases and poles.

Before streetcars 10, 12, 14 and 16 were placed in service, air

brakes were installed. When operation began on the interurban line between Edmonton and Strathcona, it was found that the original streetcars which were equipped with hand brakes only had some difficulty slowing quickly or stopping on the steep grades found on that line. The result was irregular service between the two Cities. (Edmonton Journal, December 2, 1908, p. 1 and December 23, 1908, p. 2) The four new streetcars had the air brake equipment installed in Edmonton as soon as they arrived. It should be noted that the air brake equipment could not be installed on the streetcars already in service because removing one or more units from service would have resulted in a reduction of service on the ERR. (Edmonton Journal, April 5, 1909, p. 8)

The air brake equipment was supplied by the Canadian Westinghouse Company of Hamilton, Ontario. (Edmonton Journal, July 27, 1909, p. 3) Straight, double-end equipment was installed. Each streetcar was equipped with: one type D-1-EG electric motor-driven air compressor; one cylindrical steel air reservoir tank; one safety valve for the reservoir set to open above 75 lbs./sq. in. (517 kPa) of air pressure; one electro-pneumatic pump governor set to activate the compressor when reservoir air pressure was below 50 lbs./sq. in. (345 kPa) and set to shut off the compressor when the air pressure rose above 65 lbs./sq. in. (448 kPa); one 10 inch (254 mm) bore by 12 inch (305 mm) stroke, spring return brake cylinder with slack adjuster; two motorman's brake valves, type SX-2 (one located at each end of the streetcar) and one handle; two duplex air gauges, one needle indicating reservoir pressure, the other indicating air pressure to the air brake cylinder, indicated in pounds of air per square inch; two single-pole snap switches with 5 Ampere fuses for air compressor; and two exhaust mufflers. (Canadian Westinghouse Company Air Brake Quotation Sheet, October 19, 1909)

In the basic operation of straight air brakes, the air compressor fills a reservoir with compressed air to a given pressure. When the motorman moved the handle of one of the brake valves to the extreme right, to what was called the "service" position, a path was provided between a pipe from the reservoir and a pipe to the brake cylinder. As long as the motorman held the brake handle in the service position, the air pressure going to the brake cylinder would increase until it matched the reservoir pressure. When the motorman released the brake handle, at any point, the two pipes were sealed from each other and from the atmosphere. This was called the "lap" position. In order to release the air pressure in the brake cylinder, the motorman pulled the brake handle to the extreme left to what was called the "exhaust" position. This action provided a path between the pipe leading to the brake cylinder and a pipe leading to the atmosphere. A heavy coiled spring inside the brake cylinder pushed the piston back causing the air in the cylinder to escape to the atmosphere. In order to reduce the sound caused by the escaping air, a large metal cylinder filled with cotton waste, called a muffler, was attached to the end of the exhaust pipe. (Harding & Ewing, 1926, pp. 383-385, and Westinghouse Part Catalog T3514-1, March 1926)

The most important component of the system was the air compressor. Westinghouse type D-EG compressors were available in several sizes. The size selected depended upon the size of the streetcar and the amount of air pressure required. A D-1-EG compressor, which was the smallest size available, consisted of a 600 volt D.C. motor of approximately 3.5 H.P. (2.6 kW) capacity which was connected to a crankshaft through a set of herringbone reduction gears. Herringbone gears were used because they were quieter in operation than spur gears. The crankshaft was

connected, through connecting rods, to two pistons arranged in line, that reciprocated in cylinders that were 5 inch (127 mm) in diameter. Spring-loaded check valves in the cylinder head enabled air from the atmosphere to enter each cylinder during an intake-stroke. During an exhaust-stroke, the air would be exhausted into a pipe which led to the steel air reservoir. After several minutes of operation, the action of the pistons would have produced several pounds per square inch (kPa) of air pressure in the reservoir. A pipe was connected to the reservoir that led to the governor. The air pressure in the pipe acted against a spring which was adjusted to a certain tension. When the air pressure exceeded a set value, the spring would compress, opening a pair of contacts which cut power to the compressor motor. When the reservoir pressure fell below another set value, the spring would decompress and would close the contacts enabling the compressor to provide air pressure. (Westinghouse Instruction Pamphlet T5002, August 1911)

Safety features were incorporated into the air brake system. The air compressor was mounted in a steel cradle which was hung below the frame of the streetcar. To avoid the prospect of electrical hazards, the cradle was insulated from the streetcar's frame by the use of rubber blocks. In addition, the pipes leading from both the compressor and the governor were insulated by rubber union joints. (Allis-Chalmers Company Bulletin 1508, September 1909, p. 6) In order to avoid the possibility of excess air pressure as the result of a governor failure, a spring-loaded safety valve was connected to the reservoir. The valve would open if excessive air pressure was present. The electrical circuit to the compressor was protected by a fuse. In addition, a switch enabled the system to be shut off by the motorman. (Canadian Westinghouse Company Air Brake Quotation Sheet, October 19, 1909)

The air cylinder was bolted to the bottom of the streetcar frame and was attached to the brake levers. It should be noted that hand brakes were still installed on streetcars that were equipped with air brakes. The movement of the brake piston moved the brake levers and caused the brake shoes to be applied. The purpose of the slack adjuster mentioned earlier was to compensate for brake shoe wear. As the brake shoes wore down, the brake piston had to travel further in order to provide adequate braking force. This meant that it took longer for the brakes to be applied. A slack adjuster usually prevented this from occurring. The slack adjuster consisted of a threaded shaft which was connected to a brake lever by means of a clevis. Two steel guides, called a crosshead, were attached to the end of the brake cylinder. The opposite end of the crosshead held a steel nut which was attached to the threaded shaft and which was also attached to a ratchet gear. A housing surrounding the ratchet gear, which was attached to the end of the crosshead, contained a small air cylinder which contained a spring-loaded piston which had a pawl attached to one end. A pipe led from the air cylinder to a connection in the side of the brake cylinder. If the travel distance of the brake piston became too great, a hole in the side of the brake cylinder would become uncovered. The compressed air inside the brake cylinder would then travel through the pipe to the slack adjuster cylinder. This action caused the slack adjuster piston to descend, thus engaging the pawl on the ratchet gear. When the brakes were released, the air to the slack adjuster would be cut off and the spring in its cylinder would pull the piston back up, causing the steel nut to be rotated by the action of the pawl against the ratchet gear. The movement of the nut caused the brake lever to move, which also moved the brake shoes closer to the wheels of the streetcar. In this manner, the slack adjuster

prevented the brake application time from increasing. It should be noted that when the brake lever reached the end of the crosshead, it was time for the brake shoes to be replaced. (Westinghouse Company Publication SA-2, January 1924) Figure 36 (after Westinghouse Publication SA-2, January 1924, p. 4) shows the plan and side views of a slack adjuster and brake cylinder and lever arrangement for a 10 inch by 12 inch (254 mm by 305 mm) Westinghouse brake cylinder.

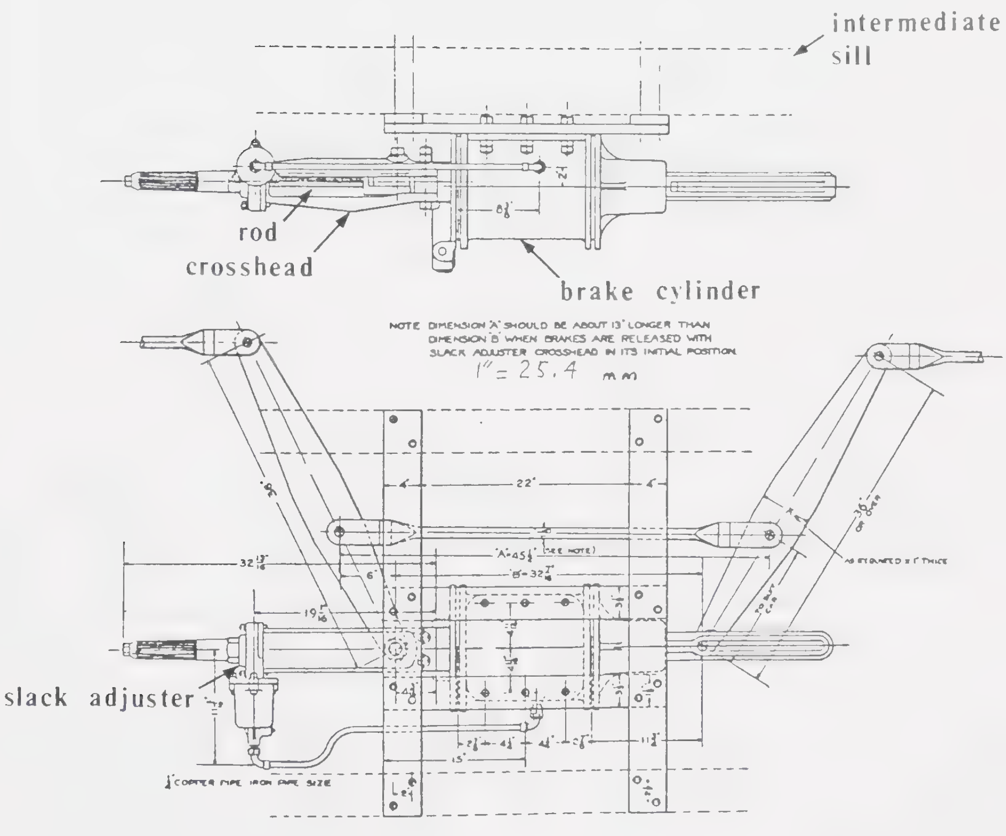


FIGURE 36. SIDE & PLAN VIEWS OF A WESTINGHOUSE FORM "J" SLACK ADJUSTER

Freight and Service Equipment, 1909

During the early part of the twentieth century, most private vehicles in Edmonton were horse-drawn carriages and wagons. The horses pulling these vehicles would defecate frequently on the streets on which they travelled. In the summer months especially, it was necessary to remove this filth quickly in order to keep odours and the risk of disease to a minimum. In the past, horse-drawn sprinkler wagons were used along paved streets in an attempt to flush the horse manure to the sides of the street where it could be more easily removed by sanitation crews. These horse-drawn sprinkler wagons had a small capacity and lacked enough pressure to be effective because they had no means to pump the water. Many street railway car builders produced large, self-powered sprinklers which were mounted on frames and which could travel along street railway tracks. Besides having a large capacity, the street railway sprinklers were usually equipped with electrically powered pumps which pressurized the water inside the tank so that it was expelled with great force. By May 1909, the City Commissioners had decided that a street railway sprinkler was required to supplement the two horse-drawn sprinklers already in service. (CECR No. 52, May 4, 1909) Two bids were received, one from the McGuire-Cummings Manufacturing Company, and the other from the Preston Car and Coach Company. The bid of the Preston Car and Coach Company was almost half the cost of the McGuire-Cummings unit. This price differential was the result of high import duties for American goods. (CECR No. 52) The sprinkler was ordered, therefore, from the Preston Car and Coach Company. It was intended that the sprinkler would primarily operate along paved streets but it was also intended to operate the sprinkler along some dirt streets in an attempt to keep dust to a minimum since such dust tended to make the passenger

streetcars extremely dirty. (CECR No. 52)

The sprinkler unit consisted of a riveted steel frame which was composed of 12 inch (305 mm) wide steel channel. Wood was placed within the channel and bolted to it in order for a wooden deck to be attached to the frame. The frame, which was strengthened by two supplemental truss rods, was placed on two Bemis 45 trucks. (Preston Car & Coach Co. Specifications of Street Sprinkler, April 1909, pp. 1-2) A 2 inch (51 mm) thick wooden deck was laid crosswise on top of the frame. Shaped oak blocks were then bolted to the deck. These blocks were designed to hold the steel tank in place. The tank, which held approximately 5,000 imperial gallons (22 730 L) was 74 inches (1 880 mm) in diameter by 20 feet (6 096 mm) in length. The tank was fabricated of riveted steel plates and was secured to the oak blocks by strips of band iron wrapped around three-quarters of the circumference of the tank to form a "U". The tank was usually filled by means of a canvas hose. A small compressor was mounted on the underside of the sprinkler's frame. Through pipes connected to the tank, the compressor was designed to provide 80 lbs./sq. in. (552 kPa) of pressure within the tank. Three inch (76 mm) diameter pipes equipped with sprinkler heads were placed at each corner of the car. Each sprinkler head could be controlled by a valve. Each end of the sprinkler car had a 34 inch (864 mm) high steel dash which protected the controller, brake staff and the motorman. A gong was also mounted on each dash. A tubular framework located above the dash held a quantity of striped canvas duck which could be drawn across the framework and secured in order to protect the crews from rain. Hand brakes only were supplied with the sprinkler. (Preston Car & Coach Co. Specifications of Street Sprinkler, April 1909, pp. 1-2)

Although the sprinkler was painted and lettered "Edmonton Radial Ry.", the precise color was not specified. It appears likely that the sprinkler was originally painted Harland's Coach Painters dark green since hand-tinted post cards of that period depict the sprinkler as being a dark green. (Post Card in Glenbow Archives, and a similar post card in the Author's Collection)

The City Commissioners hoped that the sprinkler would arrive in Edmonton during the summer but it did not arrive until September 1909, at which time the motors and electrical gear were installed. (Edmonton Journal, September 20, 1909, p. 1) It should be noted that only two GE-80A-1 motors were originally installed on the sprinkler, both motors being connected to one truck. (Plate 22, and Appendix I) Plate 22 (Provincial Archives of Alberta) depicts the Preston sprinkler in Edmonton during the summer of 1910 or 1911.

Equipment Modifications, 1909

It was mentioned in a previous section that steel track brushes were supplied with streetcars 10, 12, 14 and 16. After some use, it was found that these brushes were not successful in removing ice from the track flangeways. In an attempt to improve the cleaning of the flangeways, the ERR manufactured spring steel scrapers which were attached to the trucks on each streetcar and which replaced the track brooms. (SRDGL, Account I, October 30, 1909) These locally-made scrapers do not appear to have been too successful or appear to have been used for many years since there are few references to them in subsequent years.

The accumulation of frost on the vestibule windows was another problem that bedevilled the ERR during its early years of operation.

Plate 22. (Provincial Archives of Alberta) Preston Sprinkler

Plate 23. (Glenbow Archives) Streetcar Number 18
On Namao Avenue

Although the vestibule sashes could drop into sash pockets, this was not usually done during winter since it was extremely uncomfortable for the motorman to face the winter winds. One ERR motorman developed a solution of glycerine and alcohol which could be applied to the inside of the windows to prevent the formation of frost. This solution was used for a brief time. (SRDGL, Account 20, March 30, 1909) It was found that by double glazing the vestibule windows the formation of frost would be kept to a minimum without the use of a protective solution. All passenger streetcars on the ERR were eventually fitted with double-glazed vestibule windows. (Letter to the City Commissioners from ERR Superintendent C. E. Taylor, December 28, 1909)

During the winter of 1908-1909, it was found that the crews operating the sweeper suffered from the cold since that unit was not equipped with heaters. Electric heaters were not installed in the sweeper because there was a power shortage on the ERR at that time. In order to provide some comfort to the sweeper crews, a small wood and coal burning stove was installed in the sweeper during 1909. (SRDGL, Account 16, November 30, 1909) The stove was located near the centre of the body and a stove pipe was placed through the roof in order to allow the smoke and exhaust gases to escape. (Provincial Archives of Alberta Photograph A-1387)

Passenger Equipment, 1910

The extensions of trackage and the increase in ridership on the ERR in 1909 prompted the ERR management to ask the City Council for authorization to purchase additional passenger streetcars. On October 13, 1909, the City Council authorized the ERR to purchase six streetcars from the Ottawa Car Company since that firm was the low bidder.

(Edmonton Journal, October 14, 1909, p. 10) The six Ottawa cars were to be of similar size and construction to the four Preston cars. There were some modifications, however. The interior seating was reduced to thirty-two so that passengers could more easily enter and leave the car body. The interior seating consisted of twelve reversible cross-seats and four longitudinal seats, one of which was placed near each corner of the car body. (Ottawa Car Co. Specifications of Streetcars, November 1909, p. 1, p. 5)

The interior signal system was changed. Instead of a suspended rope running the entire length of the car body that was attached to hammer gongs in each vestibule, these streetcars were equipped with a low voltage electric bell located in each vestibule. Push buttons were located in the side posts near each seat in the car body. (Ottawa Car Co. Specifications of Streetcars, November 1909, p. 6) The bell system used several dry cell batteries connected in series to provide the necessary power to ring the bells. The push buttons were wired in parallel so that if any one were pushed, it would ring the bells. (Electric Service Supplies Co. Catalog No. 7, 1923, pp. 211-213) Unlike the four Preston streetcars, the new order of Ottawa streetcars reverted to the central cluster lighting that was used on cars 1 through 7. (Letter to the Ottawa Car Co. from the City Commissioners, November 9, 1910, p. 3) In addition, the interior of the Ottawa car bodies were finished with cherry instead of stained birch. (Ottawa Car Co. Specifications of Streetcars, November 1909, p. 4) The vestibule sashes were double glazed as well so that frost would not readily form on them. (Letter to the City Commissioners from ERR Superintendent C. E. Taylor, December 28, 1909)

The dashes of these streetcars were sheathed with vertical wood siding instead of sheet steel. There was, however, a small galvanized

sheet metal strip that was placed over a tapered piece of wood which sloped down from near the bottom of the dash to the top of the bunter. (Ottawa Car Co. Specifications of Streetcars, November 1909, pp. 2-3)

Although the cars were equipped with Brill 27-GE-1 trucks, cast iron wheels were not used. Solid rolled steel wheels, 34 inches (864 mm) in diameter, were used instead. (CECR No. 143, December 28, 1909, and Letter to the Ottawa Car Co. from the City Commissioners, November 9, 1910, p. 3) The ERR had found that the cast iron wheels were quickly worn down. It was believed that the extra cost of the rolled steel wheels would be offset by their much longer life than the cast iron wheels. (CECR No. 143, December 28, 1909)

The exteriors of the cars were finished in a similar manner to the four Preston built cars except that the roofs of the new Ottawa built cars were painted black. (See Plate 23) The numbering of the Ottawa cars was 15, 17, 18, 19, 20 and 21. (Ottawa Car Co. Specifications of Streetcars, November 1909, p. 7, and SRDGL, Account C6A) Although these streetcars were equipped with hand brakes, they were not mounted on trucks when they were sent to Edmonton. As a cost saving measure, the ERR purchased the motor and air brake equipment separately, as they had done with streetcars 1 through 7. To further reduce labor costs and to enable the trucks to be ready for installation, they were sent to Edmonton before the streetcar bodies were sent. (SRDGL, Account E-2, May 31, 1910)

The electrical equipment for these streetcars was purchased from the Canadian General Electric Company, while the air brake equipment was purchased from the Canadian Westinghouse Company. These manufacturers were selected because their products had been used by the ERR previously and had been found satisfactory since no major defects

had been encountered. (CECR No. 129, November 22, 1909) While most of the electrical equipment was the same as that supplied for earlier ERR streetcars, new heavier trolley bases were supplied. (Canadian General Electric Co. Contract for Electrical Equipment, December 6, 1909) These trolley bases, designated U.S. (for "union standard") 13, contained four springs instead of two, which pulled the trolley pole up. In addition, the spring base rested on a roller bearing which was also secured to the fixed base. The use of a roller bearing enabled the spring base to swivel smoothly and easily, thus preventing some dewirements. (General Electric Co. Bulletin 4642A, April 1909)

Before these streetcars were placed in service, fenders were installed by ERR crews. (SRDGL, Account E-2, May 16, 1910) Instead of the framework type of fender used previously, these streetcars were equipped with lifeguards at both ends, manufactured by the Hudson Bowring (HB) Company. (See Plate 23) The HB lifeguards were permanently attached to the underside of the vestibules and consisted of a wood and steel cradle which could be lowered at one end by pushing a wood and steel "gate" which was suspended from the front of the vestibule. If a pedestrian happened to fall in front of a moving streetcar equipped with such a fender, the gate, which was hinged so that it swung, would strike the pedestrian and would be deflected back towards the car body. This action would cause rods and springs attached to the gate and cradle to lower the free end of the cradle onto the rails. The cradle would contain the pedestrian, preventing the individual from being crushed by the trucks. A foot plunger located in the vestibule enabled the motorman to reset the lifeguard. (Hudson Bowring Drawing of Patent Lifeguard, 1908, and ERR Drawings of HB Lifeguard, 1912) Plate 23 (Glenbow Archives) shows the appearance of streetcar Number 18 in late 1910. The HB lifeguards,

solid steel wheels, wooden sheathing on the dash and the sliding steps and door should all be noted.

Before streetcars 15, 17, 18, 19, 20 and 21 arrived in Edmonton, ERR Superintendent C. E. Taylor wrote to the City Commissioners request-in them to order additional rolling stock at once in order for the ERR to provide adequate service on the new track extensions being constructed. (March 8, 1910) Three bids were received for new streetcars by March 29. Bids were received from: Ottawa Car Company, Preston Car and Coach Company, and the Silliker Car Company. The lowest bid was submitted by the Ottawa Car Company. The City Commissioners recom-mended that the streetcars be purchased from the Ottawa Car Company. (CECR No. 44, March 29, 1910) A contract was made with the Ottawa Car Company to supply six streetcars which were to be built to the same specifications as the previous order for six streetcars. (CECR No. 139, August 29, 1910) It was hoped that these streetcars would arrive in Edmonton by August 1910 when they would be required for service.

By the beginning of July 1910, the ERR learned that the Ottawa Car Company had not yet begun the construction of the streetcars. The ERR management, the City Commissioners and the City Council had all agreed that single ended streetcars should be tried, since such streetcars required half the number of controllers and air brake valves that double end streetcars needed. Besides reducing the capital cost of such equipment, the maintenance costs would also be reduced because there would be fewer items to be maintained. (CECR No. 139, August 29, 1910) The order for the six double end streetcars was cancelled. A new order for six single end streetcars was negotiated with the Ottawa Car Company. The ERR, nevertheless, was six passenger streetcars short by the end of 1910.

Freight and Service Equipment, 1910

The extensive track extensions of 1909 and 1910 caused the ERR management to believe that a second sweeper was required if all of its lines were to be cleared of snow quickly. In August 1910, the ERR placed an order with the Ottawa Car Company for one double end sweeper which was to be delivered no later than November 1. (Letter to the Ottawa Car Co. from the City Commissioners, August 26, 1910)

This sweeper was much shorter than the McGuire-Cummings unit. (See Appendix I) The new sweeper possessed a wooden frame and was placed upon two pedestal trucks. Pedestal trucks consisted of large steel castings that were bolted to the side sills. A slot in the bottom of each pedestal held a spring and a journal box. Steel bars were bolted between the pedestals to keep them the correct distance apart. Steel rods were also placed between the pedestals and the ends of the sweeper as extra support for the frame. Unlike the McGuire-Cummings unit, the broom assemblies on the Ottawa Car Company sweeper did not project far in front of the body. By placing the broom assemblies beneath the frame, it was possible for both broom assemblies to be driven by a single motor inside the sweeper body. (Ottawa Car Manufacturing Co. Catalog, pp. 10-11, and Plate 24) The electrical equipment for the sweeper was ordered from the Canadian Westinghouse Company because they provided the lowest bid for that equipment. (Canadian Westinghouse Co. Contract for Electrical Equipment, October 1910) The ERR had wished to place the sweeper in service immediately upon its arrival in Edmonton so the electrical equipment was sent to the Ottawa Car Company factory where it was installed on the sweeper by Ottawa Car workers. (SRDGL, Account C6B, December 9, 1910) The sweeper used three Westinghouse 101-B motors. Two of the motors were connected to the axles, one per axle,

through spur gears with a ratio of 15 to 69. These motors, which carried the designation 101-B-2, were controlled by K-10 controllers, one installed in each end of the sweeper body. The broom motor was also a WH-101-B but it was controlled by a single R-28 (straight resistance) controller. (Canadian Westinghouse Co. Contract for Electrical Equipment, October 1910, and Westinghouse Specifications of 101-B Motor) A clutch mechanism connected to the broom motor's drive axle prevented both sets of brooms from rotating at the same time. (Ottawa Car Manufacturing Co. Catalog, pp. 10-11)

The ERR specified that the sweeper was to come equipped with 14 inch (356 mm) diameter foot gongs installed at each end. The rationale for requesting such large gongs was, "such a car requires large gongs on account of the noises made by it in operation" (Letter to the Ottawa Car Co. from the City Commissioners, August 26, 1910, p. 1). The sweeper which was designated Number 2 arrived in Edmonton in early December. (SRDGL, Account C6B, December 9, 1910) It is not known what color this sweeper was painted originally or what type of heating apparatus it was provided with initially. Plate 24 (Ernie Plant, Public Archives of Canada) shows the second sweeper at the Cromdale streetcar barns in 1946. It should be noted that the sweeper was numbered 3 at this time. The pedestal trucks should also be noted.

Equipment Modifications, 1910

The successful operation of the air brakes on streetcars 10, 12, 14 and 16 encouraged the ERR to install air brakes on the first double truck passenger streetcars purchased. It should be remembered that streetcar Number 7, the single truck vehicle, could not be fitted with air brakes since there was insufficient room beneath it for the compressor

Plate 24. (Public Archives of Canada) Original Sweeper Number 2, Renumbered 3

Plate 25. (Author's Collection) Streetcar Number 29

and the reservoir tank. The Canadian Westinghouse Company was chosen to supply nine sets of double end straight air brake equipment by the end of April. It is not known why nine sets were ordered since streetcars 1 through 6 were the only passenger cars to require air brakes. The extra equipment does not seem to have been installed on the freight and service equipment. An accident report of January 1915 indicated that the combination sweeper/baggage car possessed hand brakes only. (Street Railway Department Accident Report 2325, January 19, 1915) The air brake equipment that was ordered was practically identical to the equipment that had been ordered for other ERR streetcars. The brake cylinders supplied with this order were smaller. Instead of being 10 inches (254 mm) in diameter, their diameter was only 8 inches (203 mm). The smaller cylinder size appears to have been selected because streetcars 1 through 6 were smaller than subsequent double track passenger streetcars and, therefore, did not require as much braking power. (Canadian Westinghouse Co. Contract for Air Brake Equipment, March 23, 1910) The ERR received an added inducement to install air brake equipment on their passenger streetcars when the BRC issued General Order 56 in May 1910. The Order stated that,

> On or before June 1, 1911, all electric Railway Companies under the jurisdiction of the Board, shall equip all rolling stock in use by them of thirty-seven (37) feet [11 278 mm] or over in length, or of the weight 35,000 pounds [15 876 kg] or more, with power brakes, to be approved of by the Board, in addition to hand brakes and proper sanding appliances.

From this point onwards, all passenger equipment which fell under General Order 56 would be equipped with air brakes.

Seven sets of tubular body window guards were ordered from the Ottawa Car Company in 1910. (SRDGL, Account E-1) These guards were similar in appearance to the window guards applied to the four Preston built streetcars and were installed on streetcars 1 through 7 in order

to prevent passengers from sticking their heads and arms out of the windows.

Several of the older streetcars were fitted with HB lifeguards during 1910. HB lifeguards were fitted onto all streetcars by the end of 1912. (SRDGL, Account 5B) It should be remembered, from the previous section on passenger equipment, that the HB lifeguard was considered to be superior to the framework type of fender then in use. In addition to the lifeguards, rolled steel wheels were installed on several of these streetcars since the original cast iron wheels had worn out. The ERR did not have the facilities or the equipment necessary to remove or replace wheels on the axles so the services and the equipment of the Canadian Northern Railway were obtained for these tasks. (SRDGL, Account 5B)

A different type of headlight was tried during this period. In the past, streetcars were equipped with a single incandescent headlight at each end. The light produced by this type of headlight was usually weak. In addition, as the motorman increased power to the motors, the light dimmed. In an attempt to eliminate this problem, the ERR purchased a number of arc headlights from the Union Standard Headlight Company. (SRDGL, Account E2) These headlights were similar in external appearance to the incandescent headlights. Instead of containing an incandescent bulb, the arc headlights contained two carbon electrodes which were enclosed in a large glass globe. The tips of the electrodes were spaced a short distance apart. When trolley voltage was applied to the lamp, an arc was formed between the electrodes, resulting in a bright white light. A solenoid attached to one of the electrodes served to move that electrode closer to the fixed electrode as they wore away. In addition, when power to the arc diminished, the solenoid would move the electrode

closer, thus maintaining the intensity of the arc at a constant level. (Doane & Parkham, 1926, § 22 pp. 24-27)

Although the operation of the arc headlights was superior to the incandescent headlights, the arc headlights required more power than the incandescent headlights. Arc headlights were not used, therefore, until the power shortage problems on the ERR had been eliminated. (SRDGL, Account E2)

The ERR also purchased a number of trolley catchers for use on several passenger streetcars. (SRDGL, Account E2) A trolley catcher was a cylindrical device which contained a coiled spring, a drum with several pawls on its exterior, and ratchet teeth on the inside of the housing. The purpose of a trolley catcher was to prevent the trolley pole from bouncing and flailing about should the trolley wheel dewire. In this way, damage to both the trolley pole and the overhead could be kept to a minimum. In the past, the conductor was supposed to hold the trolley rope when the streetcar travelled through curves or special work. In many instances, the conductor was otherwise preoccupied so if a dewirement did occur, damage to the overhead could result. (ERR Inspector's Report, April 13, 1911) In normal operation, the trolley catcher was mounted onto a socket which was attached to one side of the dash. The trolley rope was wrapped around the drum inside the catcher. The coiled spring pulled on the drum and the trolley rope so that it was always taut. If the trolley wire left the wire, the sudden movement of the rope would cause the drum to rotate rapidly. This rapid rotation caused the pawls on the drum to swing out and to engage the ratchet teeth which were located on the inside of the housing, thus preventing any further upward movement of the trolley pole. (Doane & Parkham, § 22 pp. 7-8) The trolley catchers were not successful since

the pawls frequently broke. This occurred because the catchers were designed to be operated with trolley bases which were set to no more than 25 pounds (11 kg) of tension. The ERR trolley bases, however, were set to exert a tension between 30 and 40 pounds (13.6 to 18 kg). (CECR No. 211, October 1, 1915)

Passenger Equipment, 1911

It was mentioned in the previous section on passenger equipment that an order for six double end streetcars (that had been placed with the Ottawa Car Company during April 1910 and which was long overdue) was cancelled and renegotiated with that Company during October. The main reason for the change from double end to single end was because the City administrators believed that there would be a considerable saving in the cost of electrical and air brake equipment and their maintenance if single end cars were adopted. In addition, it was believed that the savings would be so great that they would offset the construction costs of Y's and loops which were required for turning single end cars at the termini of routes. (CECR No. 139, August 29, 1910)

The construction of the six single end streetcars was similar to the construction of the earlier single end streetcars that were in use. There were several differences, however. Only one vestibule (the rear) was to be used for boarding so it was not necessary to have such a long front vestibule. The front vestibules were 5 feet (1 524 mm) in length while the rear vestibules were 7 feet (2 134 mm) in length. (Ottawa Car Co. Specifications of Streetcars, October 20, 1910, p. 1) A single sliding door was placed in the centre of the front bulkhead since the front vestibule was to be used only by passengers wishing to disembark. The use of two doors in the rear bulkhead was continued since passengers

could board as well as leave the streetcar through the rear vestibule. The interior seating was also modified. Fixed cross seats were used instead of the reversible type used previously. Longitudinal seating was not used in these streetcars. (Ottawa Car Co. Specifications of Streetcars, October 1910, p. 6) In order to enable passengers to pass through the rear bulkhead easily, one row of cross seats was omitted. A small single cross seat was installed against the rear bulkhead next to the sliding door. (Ottawa Car Co. Drawing F355) The interior lighting of these streetcars was similar to the lighting arrangement used on streetcars 10, 12, 14 and 16 except that the new streetcars had a lamp placed in each vestibule. (Letter to the Ottawa Car Co. from the City Commissioners, November 9, 1910, p. 3)

Single tread fixed steps were installed on these streetcars instead of sliding steps since there were doors only on one side of these streetcars. (Ottawa Car Co. Specifications of Streetcars, October 1910, p. 3) The streetcars were finished and painted in a similar fashion to the last streetcars received except that these streetcars were numbered 8, 9, 11, 13, 22 and 23. (Ottawa Car Co. Specifications, p. 7) Two Brill 27-GE-1 trucks with 34 inch (864 mm) diameter rolled steel wheels were attached to each streetcar. The motor and air brake equipment, supplied by the Canadian Westinghouse Company, were installed by the Ottawa Car Company. This was done in order that the streetcars would be ready for immediate service upon their arrival in Edmonton. (Letter to the Ottawa Car Co. from the City Commissioners, November 9, 1910, p. 1) It should be noted that the keys and the keyways for the axle gears were standardized with this order so that either General Electric or Westinghouse motors could be used. This interchangeability facilitated motor maintenance and gear replacement. (Letter to the Ottawa Car

Co. from the City Commissioners, November 9, 1910, p. 3)

The Ottawa Car Company promised delivery of the six streetcars by April 1911, which would have been one year since the initial order for six double end streetcars had been placed. The City Commissioners remained skeptical, "judging from our past experience with the Ottawa Car Company it is doubtful if the cars will be delivered before the time promised or even then" (CECR No. 191, November 22, 1910). The first four streetcars were delivered in April, while the remaining two were delivered in June. (SRDGL, Account C6E) Track and service extensions on the ERR continued, however, and it was deemed imperative that eight additional streetcars be ordered for 1911 delivery. In addition to increasing service, the additional streetcars were required to enable those already in use to be removed from service for repairs and modifications. (CECR No. 191, November 22, 1910)

The order for eight streetcars was split between the Ottawa Car Company and the Preston Car and Coach Company. This action was taken to ensure that at least four of the streetcars would be in Edmonton in time for the summer exhibition and fair period. As far as the ERR and the City Commissioners were concerned, the Ottawa Car Company's record for delivery on time was poor and although that company had submitted the lowest bid, it was doubtful that the streetcars would be delivered by the time promised. (Letter to the Ottawa Car Co. from the City Commissioners, December 7, 1910, p. 3) The remaining four streetcars were ordered from the Preston Car and Coach Company solely because that company had delivered their products to Edmonton quickly. In a letter to the Preston Car and Coach Company, the City Commissioners stated, "the order is placed with you at a price considerably higher than quoted by other builders of the same type of car, and on award

of the contract to you at such a higher price is based upon our confidence in your ability to make delivery within the time period" (December 7, 1910, pp. 3-4) The contract with the Ottawa Car Company was finalized by the end of December while the contract with the Preston Car and Coach was finalized in February 1911. (Ottawa Car Co. Contract, December 30, 1910, and Preston Car & Coach Co. Contract, February 6, 1911)

The basic construction of the eight streetcars was the same as the construction of the previous twenty-three streetcars. The length of the bodies, however, was extended to 30 feet 6 inches (9 296 mm). (Ottawa Car Co. Specifications of Streetcars, December 1910) This addition of 2 feet 6 inches (762 mm) enabled each body to have an additional side window, making a total of eleven body windows on each side. Two additional cross seats could be installed in each of the streetcars, thus increasing their seating capacity. (Letter to the Preston Car & Coach Co. from the City Commissioners, December 7, 1910, pp. 1-2; see also Appendix I) An additional window was also placed in each side of the monitor. The appearance of the windows differed between manufacturers. The sashes installed by the Ottawa Car Company were rectangular with slightly rounded corners at the top. (See Plate 23) Preston Car and Coach, however, designed their sashes so that the tops curved. With the exception of the centre body window which had square corners, the tops of the body windows were curved so that each formed a half of a semi ellipse. The tops of two adjacent windows would, therefore, form a semi ellipse. (See Plate 25) With the exception of the centre window which was rectangular, the top of each monitor window was curved to match the corresponding body window below. Curved window tops served no structural purpose but were used for esthetic reasons. It is most likely that these Preston built streetcars had curved window tops because

they were constructed along with an order for several Calgary streetcars, which were usually constructed with curved window tops. (Letter to the Preston Car & Coach Co. from the City Commissioners, December 7, 1910, and Photographs of Calgary Streetcars in the Glenbow Archives) It is likely that the Preston Car and Coach Company fabricated only one type of sash in order to keep production costs to a minimum.

The ERR had found the Bemis trucks to be rough riding and difficult to maintain since they required different parts than the Brill 27-GE-1 trucks. In order to maintain some semblance of truck standardization, eight pairs of Brill 27-GE-1 trucks were ordered through the Ottawa Car Company with instructions that four pairs were to be sent to the Preston Car & Coach Company. The electrical and air brake equipment was supplied by the Canadian Westinghouse Company and was installed by the streetcar builders before the units were sent to Edmonton. (Letter to the Preston Car & Coach Co. from the City Commissioners, January 24, 1911, pp. 1-3)

Instead of track brushes, commercially manufactured spring steel scrapers were installed at the front of each truck. These scrapers were manufactured by the Root Spring Scraper Company of Kalamazoo, Michigan. (Letter to the Preston Car & Coach Co. from the City Commissioners, January 24, 1911, p. 3, and Electric Railway Journal, August 20, 1910, p. 316) Gravity operated sanders were not supplied with these streetcars. Instead, air operated (pneumatic) sanders were installed. The placement of the sanders in these streetcars differed from their placement in double end streetcars. In single end streetcars, both sanders were located at the front of the streetcar, each being located over one of the rails. (Letter to the Preston Car & Coach Co. from the City Commissioners, January 24, 1911, p. 3) A pneumatic sander consisted

of an iron casting which was shaped so that sand would collect at the bottom. Sand could leave the casting through a curved section which prevented the sand from falling out by gravity. A small pipe, which was attached to the air brake pipe leading from the main reservoir, was installed in the front vestibule between the controller and the brake valve. A small valve was then connected to the end of the pipe. Through means of a small handle which was connected to a spring-loaded valve seat, the air flow could continue through the valve when the handle was depressed. Another pipe leading from the valve was connected to the side of the casting near its base. When the valve handle was depressed, the resulting blast of air in the sander casting forced a quantity of sand onto the rails. (Electric Service Supplies Co. Catalog No. 7, 1923, pp. 457-462, and Cyclopedia of Applied Electricity, Vol. III, 1908, pp. 64-65) The major advantage of a pneumatic sander over a gravity sander was that a vast array of levers, which were prone to freezing in winter, was not required.

Electric heaters were not installed on these streetcars. The electric heaters that were then in use required copious amounts of electricity in order to heat the interiors of the streetcars effectively. The ERR, during this period, was in the midst of a power shortage and the use of electric heaters intensified the power shortage problem. In addition, the vestibules were rarely warm enough for the motorman or the conductor, although large electric heaters had been installed there. (Letter to the Ottawa Car Co. from the City Commissioners, January 25, 1911, p. 4; Letter to the Preston Car and Coach Co. from the City Commissioners, January 25, 1911, p. 4; and CECR No. 211, October 1, 1915) It was the intention of the ERR to install coal-fired forced air heaters in each streetcar before winter weather arrived, thus eliminating the

need for electric heaters. (Letter to the Preston Car & Coach Co. from the City Commissioners, January 24, 1911, p. 4) The forced air heaters will be described in a subsequent section.

The eight streetcars were painted in a similar fashion to the latest streetcars received. The words "entrance" and "exit" were also painted on the step risers below the appropriate doors. (Letter to the Preston Car & Coach Co. from the City Commissioners, January 24, 1911, p. 6) The four streetcars from the Ottawa Car Company were numbered 24 through 27, while the four Preston built streetcars were numbered 28 through 31. (Letter to the Ottawa Car Co. from the City Commissioners, January 20, 1911, p. 2, and Letter to the Preston Car & Coach Co. from the City Commissioners, January 4, 1911, p. 5)

Streetcars 28 and 29 arrived in Edmonton on June 16 and streetcars 30 and 31 arrived on July 4. (SRDGL, Account C6D) Streetcars 24 through 27 arrived between August 15 and September 8. (SRDGL, Account C6E) The City Commissioners' earlier prediction that the Ottawa Car Company would deliver its streetcars late was proven to be correct. The continual tardiness of the Ottawa Car Company was to ensure that further orders for streetcars placed by the ERR would go to competing builders. Plate 25 (Author's Collection) shows streetcar Number 29 as it appeared at some point towards the end of the Second World War. The curved window tops should be noted. It is also important to note that the paint scheme, steps and other exterior details not described previously were added between the time the streetcar was built and the time the photograph was taken.

Freight and Service Equipment, 1911

At some point before October 1911, the ERR decided that it required

a sand car. A sand car was a streetcar that could be used to distribute sand along the right of way as well as being able to deliver sand to other streetcars in service. The earliest available Street Railway Department Monthly Report (October 1912) notes that there were thirty passenger streetcars in addition to one sand car in operation on the ERR during October 1911. A press report of November 1911 also states that there were only thirty passenger streetcars in service. (Railway and Marine World, p. 1071) It seems likely that the single truck streetcar Number 7 was used as the sand car since it was subsequently used for overhead line maintenance and construction purposes.

Equipment Modifications, 1911

It was mentioned in a previous section that in 1909, the first ERR sweeper was heated with a wood and coal burning stove. The reason for using a stove instead of electric heaters had been to reduce the sweeper's demand for electricity since there was a power shortage on the ERR at that time. During 1910, the Calgary Municipal Railway replaced the electric heaters in some of its passenger streetcars with a newly developed coal and wood burning forced air heater. This was done for two reasons. Firstly, that system also suffered from a power shortage and, secondly, it was much cheaper to heat the streetcars in this fashion. The heaters, however, required a smoke stack and the sight of smoke coming from a passing streetcar was not considered esthetically pleasing by some citizens. (Edmonton Bulletin, October 15, 1910)

The ERR, nevertheless, took great interest in these heaters because it was in the midst of a severe power shortage. The Superintendent visited Calgary to view the heaters in operation and in early 1911, the ERR installed a similar heater on one of its streetcars. (Edmonton Journal,

May 2, 1911, p. 12) The heater, which was obtained from the Peter Smith Heater Company of Detroit, Michigan, consisted of a small cast iron stove (sometimes called a fire pot) and ash pit which was surrounded by two square sheet steel cabinets, one inside the other. The top of the larger cabinet supported a small electric motor which rotated a squirrel-cage blower. The blower, when in operation, drew cold air into the outer cabinet and forced it into the smaller cabinet where it was heated. A duct which was connected to the inner cabinet distributed the heated air along one side of the streetcar body at floor level. In this manner, the air inside the streetcar was being constantly circulated and warmed. A stove pipe led from the stove through the roof of the streetcar where smoke and gases could escape. (Electric Railway Journal, December 3, 1910, pp. 1105-1106) Figure 37 (after Drawing in Electric Railway Journal, p. 1106) shows the cross-sectional appearance and operating principles of a Peter Smith model 2-P heater.

The operation of the Peter Smith heater was considered to be more efficient and less expensive than the electric heaters. By the end of October 1911, all ERR streetcars, including work and service equipment, were equipped with one model 2-P Peter Smith heater each. (SRDGL, Account C6) In most instances, the heaters appear to have been installed near one end of the streetcar body. (Photographs in the Author's Collection)

During 1911, the ERR experimented with different methods of route identification on their passenger streetcars. In the past, the streetcars carried reversible boards which had the name of a destination painted on each side. Such a sign may be seen in Plate 23. These signs were not readily visible at night. The ERR management decided to experiment with roof-mounted illuminated signs which contained a roll of black colored

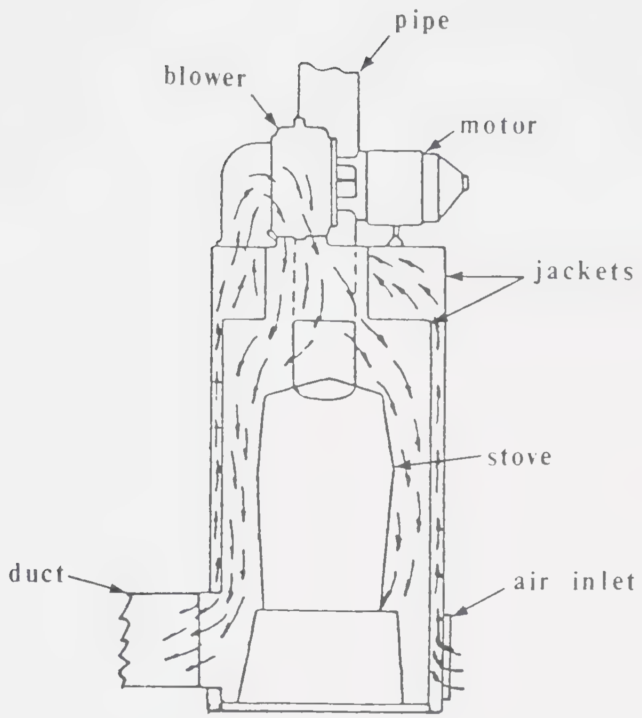


FIGURE 37. PETER SMITH HEATER

canvas which had the destinations silkscreened in white lettering. In addition, two colored marker lamps installed at both ends of the streetcar would provide a color code for each route. The marker lamps were thought to be visible from a greater distance than the lettering on the signs. Only one passenger streetcar was fitted with colored marker lamps in 1911. The lamps, which were obtained from the Boston, Massachusetts firm of Peter Gray and Sons, were small sheet metal boxes which had a colored lens on each of four adjacent sides. The bottom of the lamp was affixed to the hood of the streetcar while the top contained a housing for an incandescent bulb. (SRDGL, Account C6, and Edmonton Bulletin, October 26, 1911) As many as four different colored lenses could be installed on each lamp. The box area around the lenses were painted the same color as the lens. In this manner, the route color could be seen during daylight hours. A handle protruding into the vestibule enabled

the lamp to be rotated until the desired color was facing forward.

The illuminated signs and the colored marker lamps were considered to be superior to the reversible signs so the ERR management decided to equip all passenger streetcars in service with them. This general conversion, however, did not begin until 1912. (Railway and Marine World, January 1912, p. 41)

Passenger Equipment, 1912

In February 1912, the Cities of Edmonton and Strathcona were to be amalgamated. Part of the Edmonton Strathcona Amalgamation Act called for the construction of several new streetcar lines by the City of Edmonton in the former City of Strathcona. Some of the new lines were to be in operation by the end of 1912. (Statutes of Alberta, 1911-1912, Chapter 66, pp. 529-531, see also Chapter III) In addition, several new track extensions in Edmonton were to be built. In order to have enough rolling stock to operate these new lines, the City of Edmonton ordered fifteen new streetcars. It was imperative that these streetcars arrive in Edmonton before the end of 1912. These streetcars were ordered from the St. Louis Car Company. That company guaranteed delivery of all fifteen streetcars by the middle of June or it would pay the City a monetary penalty for each day that delivery was delayed. (Agreement between the St. Louis Car Co. and the City of Edmonton, February 9, 1912, pp. 1-2) To enable these streetcars to be used for short turn service and on stub lines, the streetcars were constructed as double end units.

Unlike the previous thirty-one passenger streetcars, the side, end and intermediate sills of the St. Louis streetcars were composed entirely of steel channel, bars, and angles which were riveted together. Additional

wooden sills were added to facilitate the attachment of the sides and floor. (St. Louis Car Co. Specifications of Streetcars, January 20, 1912, pp. 1-2) A steel underframe gave the body and the vestibule greater strength and eliminated the need for truss rods. Although streetcars fabricated entirely of steel were available, such vehicles were much heavier than composite wood and steel cars. It is doubtful as well whether the ERR's temporary track construction could have withstood the weight of all steel streetcars.

The bodies of the St. Louis streetcars were constructed in a similar manner to the other ERR streetcars except that the roofs of the St. Louis cars did not have monitors; a flat arch roof was selected instead. To allow for ventilation, the vestibule hoods were placed so that they were attached to the bulkheads a few inches (mm) below the level of the body roof. Special steel ventilators were placed at each end of the streetcar between the top of the hoods and the bottom of the body roof. In order to protect the canvas on the roof from damage by the boots of service crews, a running board (several strips of pine or oak placed longitudinally) was placed along the centre of the body roof. (St. Louis Car Co. Specifications, p. 2) Cost reduction was the prime reason why the ERR selected the arch roof for these streetcars instead of a monitor roof which was available. (Agreement between the St. Louis Car Co. and the City of Edmonton, February 9, 1912)

The eleven body windows on each side, which were square in shape, slid into pockets in the ceiling since there was considerable space available there. It should be noted that because there were no sash pockets in the wainscoating, there was only an extremely small air space between the wainscoating and the body framing. This lack of insulation tended to increase the heat loss from these streetcars. In subsequent years,

the ERR received many complaints that these streetcars were much colder than other streetcars on the system. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, January 23, 1928, p. 2) In order to protect the external sheathing of the body from blows and sideswipes from road vehicles, a steel pipe called a bumper rod was placed along the bottom of the sheathing on each side of the body. The pipe was secured to the underframe with bolts. (St. Louis Car Co. Specifications of Streetcars, January 1912, p. 9)

The seating in these streetcars was laid out in the same fashion as the seating in streetcars 10, 12, 14 and 16. In addition, the St. Louis cars had hand poles suspended horizontally above each longitudinal seat with steel brackets. Leather straps attached to the hand poles enabled those passengers who were standing to hold onto something substantial. (St. Louis Car Co. Specifications, pp. 4-5) In the past, standees had to hold onto seat handles or onto the bulkheads. A seat for the motorman was to be placed in each vestibule. The seat assembly, which consisted of a small wooden seat which was supported on an adjustable steel pole, was not found on the earlier ERR streetcars. (St. Louis Car Co. Specifications, p. 5) The interior lighting of these streetcars consisted of a line of single bulbs placed along the centre of the ceiling. The light was evenly distributed throughout the interior because there was no monitor or other obstructions in the ceiling. A total of fifteen bulbs were installed in the body of each streetcar, while there was one bulb in each vestibule.

The interior signal system included both a rope and hammer gong arrangement as well as electric bells which were operated from push buttons located in the window posts beside each seat. The electric bell system for these streetcars was designed to operate using trolley voltage,

thus saving the cost of replacing dry cell batteries. (St. Louis Car Co. Specifications, p. 6)

Illuminated signs, manufactured by the Hunter Company, were installed on both hoods of each streetcar as well as on the roof in the middle of each side. Each sign contained one incandescent bulb for illumination, in addition to a length of silkscreened canvas that was moved by an arrangement of geared rollers. Two marker lamps, manufactured by Peter Gray and Son, were placed at both ends of each streetcar on either side of the illuminated sign. Each marker lamp held four lenses. Their colors were: red, green, blue and clear. Each marker lamp was illuminated by a single incandescent bulb. All the bulbs on the streetcars, with the exception of the headlights, were 16 candle power (20 W) incandescent bulbs. (St. Louis Car Co. Specifications, pp. 7-8) The marker lamps and the hood-mounted illuminated signs were protected from the trolley pole by a steel framework which also included a hook to hold down the trolley pole when it was not required. (Plate 26)

A single arc headlight was supplied with each streetcar. These arc headlights were designed to be portable. They were mounted on the dashes of the streetcars by means of hooks which fitted into a bar which was bolted to the dash. Two bayonet plugs (an insulated housing which accepted a straight section of copper or steel bar) located either directly below the bar or immediately below the bunter enabled the headlight wires to be connected to the power supply. When the streetcar was to reverse its direction of travel, the motorman or the conductor would unplug the headlight, unhook it from the dash, and reinstall it at the opposite end. In addition, such headlights could be removed during the day, thus reducing the likelihood that they would be damaged. (St. Louis Car Co. Specifications, p. 8)

The vestibules, which were designed for PAYE fare collection, were each approximately 7 feet (2 134 mm) in length. The vestibules were sheathed below the belt rail, on the exterior, with number 12 gauge sheet steel. Inside, the vestibules were finished in natural cherry above the belt rail and with number 16 gauge sheet steel below the belt rails. (St. Louis Car Co. Specifications, pp. 1-4) Single tread folding steps were installed at two diagonal corners of the streetcar. The folding steps were lowered by a lever assembly which also opened the doors above the steps. It should be noted that the other two doors were single width sliding doors which had a single tread fixed step below them. These doors were intended for use by passengers who were leaving the streetcar. (St. Louis Car Co. Specifications, p. 3) The folding doors had grab handles mounted on the inside in order that they would be available only when the doors were open. The grab handles for the sliding doors were located directly inside the vestibules. The placement of the grab handles, as well as the use of folding steps, prevented passengers from boarding the streetcar from the wrong side, or from boarding the streetcar once it was underway.

The fifteen St. Louis streetcars were to be equipped with two Brill 27-GE-1 trucks each but St. Louis 47-B trucks were used instead. This came about because the St. Louis Car Company agreed to reduce the total price of the contract if their own trucks were used, thus providing advertising for the products in Western Canada. (Letter to the City Commissioners from J. I. Beggs, St. Louis Car Co. President, March 11, 1912) The 47-B truck was similar in appearance to the Bemis 45 truck. The 47-B truck, however, used two small elliptical springs to support the truck bolster instead of large leaf springs. (St. Louis Car Co. Drawings of 47-B Truck, 1912) The 47-B trucks, therefore, were somewhat smoother

riding than the Bemis or the Brill trucks.

The color scheme of these streetcars was similar to the color scheme of streetcars 24 through 31. There were some differences, however. The name "Edmonton Radial Railway" was placed on the letterboards instead of below the belt rails on the sheathing. In addition, a 1 inch (25.4 mm) high gold stripe was painted along the entire length of each side of the body 2 inches (51 mm) above the bottom of the sheathing. The streetcars were numbered 32 through 46 and were sent to Edmonton without motors or air brake equipment. (St. Louis Car Co. Specifications of Streetcars, January 1912, pp. 6-8) All fifteen units were delivered to Edmonton by the end of June 1912. (SRDMR, May-June, 1912)

The motor and control equipment was furnished by the Canadian General Electric Company while the air brake equipment was supplied by the Canadian Westinghouse Company. (Canadian General Electric Co. Contract for Equipment, February 1, 1912, and Railway and Marine World, March 1912, p. 150) These streetcars were also wired so that they could be equipped with an ammeter that would record the power used by the motors, thus providing an estimate of power consumption. (St. Louis Car Co. Specifications of Streetcars, January 1912, p. 8) The ERR purchased the meters from the Ferranti Meter and Electric Company of Montreal. The use of these meters was a dismal failure because the extreme temperature fluctuations in Edmonton caused them to jam. (CECR No. 211, October 1, 1915)

One Peter Smith heater was installed in each streetcar before the end of 1912. (SRDGL, Account C6) While the stoves were installed inside the car bodies, the smoke stacks were placed in the hoods. This was done because a smoke stack placed through the body roof would have interfered with the opening of the windows since they slid into the ceiling.

Plate 26 (Provincial Archives of Alberta) shows the appearance of streetcar Number 44 at some time during 1913. The following should be noted: marker lamps at both ends, illuminated signs, running boards, folding steps, fixed step, and the smoke stack. It should also be noted that the message "Have Exact Fare Ready" was added in 1913.

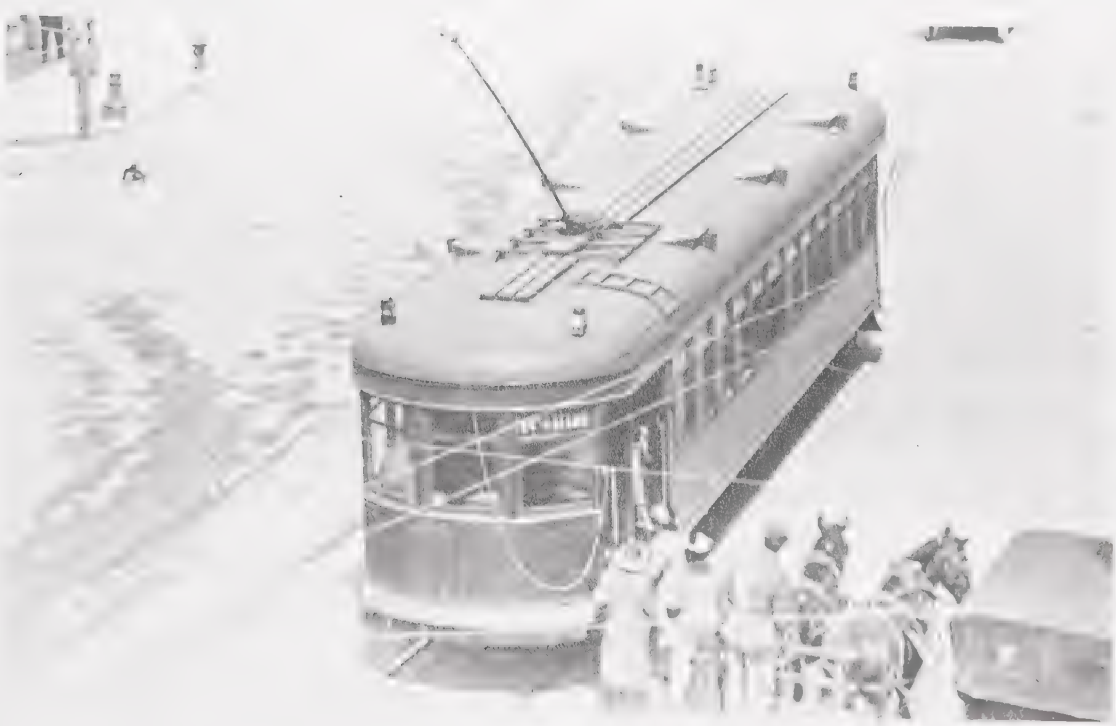
Freight and Service Equipment, 1912

By 1912, the ERR had an established freight handling business. Part of the freight service involved the movement of railroad boxcars and flatcars from the steam railroads to businesses located along ERR lines. (CEAR, 1912, p. 207) None of the ERR's rolling stock was well suited for this task. In addition, no ERR rolling stock could transport long sections of rail which were required for track extensions. In early 1912, therefore, the ERR ordered one "work car" from the Mc-Guire-Cummings Manufacturing Company. (Railway and Marine World, March 1912, p. 150, and SRDGL, Account C6B)

The "work car" was a motorized flat car. The frame was fabricated of steel and was placed on two McGuire-Cummings type 10-A MCB trucks which were the same type of trucks that were applied to the ERR's combination baggage car and sweeper. A wooden deck was then attached to the top of the frame. A small wooden cab was placed at one end of the deck. The cab rested on small posts which were placed at each corner of the cab. By having the cab floor raised above the deck, long sections of rail could be carried without the ends of the rails protruding beyond the length of the work car. (See Plate 7) Stake holders, provided by several steel brackets riveted to the sides of the frame, enabled loose loads such as lumber to be carried safely on the work car. Heavy draw bars with large coupler pockets were provided at both ends of the work

Plate 26. (Provincial Archives of Alberta) Streetcar Number 44 in 1913

Plate 27. (Glenbow Archives) Streetcar Number 73 in 1914



car so that the unit could pull or push box cars and flat cars. The couplers for the unit conformed to MCB specifications but were not obtained and installed until 1913. (SRDGL, Account C6B) It is likely that chains were used to lash the work car to railroad rolling stock before the couplers were installed. (See Plate 7) From its appearance in Plate 7, in addition to specifications for later service equipment, it seems that the cab and frame of the work car were painted buff with black lettering and numbering. (ERR Specifications for Line Car L-1, 1913 and SRDGL, Account T13)

The motor and air brake equipment, which was obtained from the Canadian Westinghouse Company, was installed when the work car arrived in Edmonton. (SRDGL, Account C6B, and ERR Valuation Record, December 31, 1913 Plate 7 (Glenbow Archives) shows the ERR work car at the C. F. Taylor Lumber Yard at some point either in late 1912 or early 1913. The railroad box cars, the elevated cab, the stakes and the absence of a rear coupler should all be noted.

Equipment Modifications, 1912

It was mentioned in a previous section that in late 1911, the ERR had decided to install illuminated signs and marker lamps on all its passenger streetcars. This conversion work was begun in 1912 and entailed rewiring the lighting circuits of the streetcars. In most instances, a total of five series circuits with five lamps in each circuit were arranged in each streetcar. The markers, illuminated signs and the interior lamps comprised the apparatus in the circuits with the exception of two signs which were placed in the middle of the monitor on each side. These signs were illuminated by the interior lamps. A special three-way switch on one of the circuits enabled the motorman to extinguish the vestibule

lamp or lamps when the streetcar was in motion. When the switch was set in this position, an additional body lamp or lamps was illuminated. In the case of a streetcar equipped with incandescent headlights, each headlight was wired into circuits, which included a vestibule lamp. When the three-way switch was set to one of the "on" positions, the vestibule lamp would be illuminated and the headlight would be off. When the second "on" position was selected, the vestibule lamp would be extinguished and the headlight illuminated. (ERR Light Wiring Diagrams, 1912-1913)

The installation of the illuminated signs and marker lamps enabled the ERR to make extensive repairs on some of the original streetcars. (CEAR, 1912, p. 206) A press report of November 23, 1911 noted that some of the streetcars had been stored out of doors because of insufficient room in the car barns and these cars were in need of some repairs because of this extensive exposure. (Edmonton Journal, p. 1) Although it is not known how many streetcars were repaired and repainted, it is known that streetcars 4, 5 and 6 were extensively overhauled during 1912. In this overhaul, these streetcars were converted to single end PAYE units. (ERR Valuation Record, December 31, 1913) The lengths of the rear vestibules on these streetcars do not appear to have been altered at this time. It should be noted that at some point between 1912 and 1914, the Brill trucks under streetcars 1 and 3 were exchanged with Bemis trucks taken from streetcars 10, 12, 14 and 16. (SRD Table of Car Weights and Levers, circa 1920, ERR Specifications of Line Car L-1, 1913, and SRDGL, Account F16H)

Exterior mounted rear view mirrors were installed on most ERR rolling stock beginning in 1912. These rectangular mirrors were manufactured by the Indianapolis Brass Company of Indianapolis, Indiana and

were bolted to the right-hand corner post of each forward-travelling vestibule. (SRDGL, Account T13) The mirrors appear to have been installed on most work and service equipment with the exception of the sprinkler. (Plate 9, and Photographs in the Glenbow Archives and in the Provincial Archives of Alberta) The mirror enabled the motorman to see the right-hand side of the streetcar. This was important especially when a streetcar was making a right turn on a paved street with a curb. It was possible for a road vehicle to be caught between the streetcar and the curb as it turned the corner. If the streetcar did not stop, the vehicle could be severely damaged. The mirror enabled the motorman to watch for this hazard.

During this period, each streetcar was equipped with two kerosene lanterns which had red globes. (SRDGL, Account T13) A nail placed immediately below the belt rail on each vestibule held the lanterns. It should be recalled from a previous section that the City Commissioners ordered these lanterns to be carried because one streetcar had rammed another which had lost power on a darkened section of track. These lanterns were in use for a short period of time. By September, the ERR had decided to equip most of its passenger streetcars with arc headlights. (SRDGL, Account T13) It should be remembered that arc headlights had been used in 1910 but were discontinued because of heavy power consumption. The new arc headlights, manufactured by the Crouse-Hinds Company, were of the portable "luminous arc" variety. (SRDGL, Account T13)

The electrodes of a luminous arc lamp differentiated this type of headlight from traditional arc lamps. A luminous arc lamp was designed to use less current than ordinary carbon arc lamps. One electrode of a luminous arc lamp consisted of copper, while the other consisted of

a mixture of magnetite, chromium and titanium which was packed in a small iron tube. (Doane & Parkham, 1926, § 22 pp. 26-27) The interior of a luminous arc headlight did not usually contain a reflector since the light produced by the arc was extremely bright. One luminous arc lamp was assigned to each streetcar and they were installed as the streetcars underwent rewiring for illuminated signs and marker lamps. (Photographs in the Author's Collection) As each streetcar received a luminous arc headlight, the kerosene lanterns could be dispensed with. (SRDGL, Account T13)

Two different brands of trolley catchers were purchased during 1912 and were installed on many of the passenger streetcars. Both types were found not to be strong enough and they were removed. (CECR No. 211, October 1, 1915) It should be noted that the sockets used to hold these catchers were left on many of the streetcars' dashes. (Photographs in the Author's Collection, and Photographs in the Glenbow Archives)

Passenger Equipment, 1913-1914

It was mentioned in Chapter II that the City Council in late 1912 gave its approval for the construction of several miles (km) of new track. At that time, it seemed as if the ridership on the ERR was going to continue to increase at a rapid rate. (CEAR, 1912, pp. 1-4 & p. 208) In order to accommodate the anticipated increase in ridership as well as providing service on the new track, the City Council approved the purchase of thirty-five additional streetcars. By the end of November 1912, the City had finalized a contract with the Preston Car and Coach Company for the supply of thirty-five streetcars. (Preston Car and Coach Co. Contract for Streetcars, November 20, 1912)

These streetcars were substantially different in appearance from

the earlier ERR passenger streetcars. The bodies of these streetcars were to be 33 feet 3 3/4 inches (10 154 mm) in length, which was more than 3 feet (914 mm) longer than the bodies of streetcars 32 through 46. (Preston Car and Coach Co. Specifications of Streetcars, November 8, 1912, p. 1) Like streetcars 32 through 46, these Preston vehicles had steel frames. The frames of these streetcars, however, were more substantial than those found on streetcars 32 through 46. Larger steel angle bars were used on the Preston streetcars in addition to 6 inch (152 mm) high steel "I" beams for the intermediate sills, while 4 inch (102 mm) wide steel channel was used for the end sills. All parts of the body and vestibule frame were riveted together. (Preston Car and Coach Co. Specifications, pp. 1-2) The streetcars were to be single end so the front vestibule length was 5 feet (1 524 mm), while the rear vestibule length was 7 feet (2 134 mm) in order to accommodate the full PAYE system.

The flooring of these streetcars, with the exception of the grooved matting down the centre of the bodies, was composed of a double layer of 7/8 inch (22.5 mm) thick tongue and groove oak boards. (Preston Car and Coach Co. Specifications, p. 3, and Letter to ERR Superintendent W. Woodroofe from Preston Car and Coach Co., November 20, 1912) The interiors, including the vestibules, were finished in cherry. The seating arrangement, which was similar to the seating arrangment of streetcars 24 through 31, consisted of nine pairs of fixed cross seats. In addition, two 5 foot 5 inch (1 651 mm) long longitudinal seats were placed near the rear of each streetcar. Strap hangers were placed above the longitudinal seats. A Peter Smith heater and a sheet metal fuel box were installed on the left-hand side of the front vestibule. The heater was probably placed in the vestibule because little heat had reached the

motorman in streetcars where the heater was installed inside the car body. (Preston Car and Coach Co. Specifications, pp. 6-7)

Each side of the streetcars were framed for twelve body windows which were square in shape and which were designed to drop into sash pockets in the wainscoating. The exterior window guards consisted of steel netting which covered the entire 24 inch (610 mm) sash opening. (Preston Car and Coach Co. Specifications, p. 5) The roofs on these streetcars were of the "turtle back" design. A turtle back roof was a type of symmetrical arched roof in which separate hoods were eliminated. The roofline was unbroken except for three evenly spaced ventilator ducts placed along each side. (See Plate 27) A running board composed of oak or pine boards was installed on each streetcar. The exteriors below the belt rails were sheathed with narrow V-joint poplar boards. The vestibules were not sheathed with sheet steel. The bottom of the body sheathing was protected by an iron pipe, as were streetcars 32 through 46. (Preston Car and Coach Co. Specifications, p. 4)

The doors, which were installed on the right-hand side only, were designed to fold. The steps were fixed single tread and were similar to the fixed steps applied to earlier ERR passenger streetcars. Marker lamps were installed on the roof at both ends but roof mounted signs were not used. Smaller interior signs that were installed in the upper part of the sashes were used instead. Such signs were less likely to be affected by snow and extremely cold weather. One sign was installed in the right-hand window of the front vestibule while another was installed in the right-hand window of the rear vestibule. These signs were illuminated by a single bulb each. Two similar signs were installed in the sixth (counted from the front vestibule) body window on each side. These signs, which did not contain bulbs, received their illumination from the

bulbs in the interior of the streetcar. (Photographs in Glenbow Archives, and ERR Light Wiring Diagrams, 1912-1913)

The exterior finish on these streetcars was similar to the finish on streetcars 32 through 46 except that the numbers were placed near both ends of each bunter instead of on the dashes. (Preston Car and Coach Co. Specifications, p. 7) The streetcars were numbered 47 through 81. (SRDGL, Account C6A) A motorman's mirror as well as a luminous arc headlight were supplied with each unit. (Preston Car and Coach Co. Specifications of Streetcars, November 8, 1912, p. 6 & p. 8)

The weight of each body, without trucks, electrical equipment or air brakes, was approximately 22,000 pounds (9 979 kg). (Preston Car and Coach Co. Specifications, p. 1) These streetcars were much heavier than earlier ERR passenger equipment. Heavier trucks than the Brill 27-GE-1 trucks were required if these streetcars were to operate efficiently and smoothly. Number 0-50 trucks manufactured by the Standard Motor Truck Company of Butler, Pennsylvania were selected for these streetcars. (Preston Car and Coach Co. Contract for Streetcars, November 5, 1912, p. 1) The Standard 0-50 truck, which had a 4 foot 6 inch (1 372 mm) wheel base, consisted of heavy open hearth steel forged side and end frames which were riveted together. Unlike the Bemis 45 and the St. Louis 47-B trucks, the Standard 0-50 trucks also contained large equalizer bars which were connected to the journal boxes on each side of the truck. (Standard Motor Truck Co. Specifications of 0-50 Motor Truck, May 1912) An equalizer bar tended to dampen any bumps that the truck wheels encountered as they passed over the track. Large elliptical springs combined with the equalizer bars enabled these trucks to provide a smoother ride than the St. Louis and the Bemis trucks. Two 0-50 trucks were placed beneath each streetcar.

In order for the ERR to be able to place these streetcars in immediate service, the Preston Car and Coach Company was paid to install both the electrical and the air brake equipment before sending the units to Edmonton.

Although these streetcars had been constructed as single end vehicles, they were fitted with controllers and air brake valves for double end operation. (Canadian General Electric Co., Canadian Westinghouse Co., and Allis-Chalmers Co. Contracts for Electrical and Air Brake Equipment, 1912) Only one trolley pole was installed on each streetcar. It seems likely that the ERR installed double end equipment in these streetcars in direct response to a serious accident which occurred in June 1912. Many streetcars had been using a Y at the intersection of Kirkness (95th) Street and Alberta (118th) Avenue. On June 5th, a single end car was using the Y in order to travel south on Kirkness Street. The conductor had given the motorman the signal to back up. Immediately after the streetcar had started to move, a man on an adjacent sidewalk yelled to the conductor that a small child was on the track directly behind the streetcar. All the conductor could do was to give the motorman the stop signal. By the time the streetcar had stopped, the child had been killed. (Edmonton Bulletin, June 6, 1912, p. 12) Some citizens suggested, subsequently, that if the conductor had been able to apply the brakes, the death might have been prevented. (Edmonton Bulletin, June 8, 1912, p. 12) It is probable that double end equipment was installed to enable the motorman or conductor to control the streetcar from the rear vestibule during backing maneuvers.

The order for the electrical and air brake equipment was split unequally between three manufacturers, Allis-Chalmers, Canadian General Electric and Canadian Westinghouse. (Canadian Railway and Marine World,

February 1913, p. 92) There was little difference in price between the proposals from Canadian General Electric and Canadian Westinghouse. The prices submitted by Allis-Chalmers were considerably higher because that firm manufactured its apparatus in Milwaukee, Wisconsin. (Canadian General Electric Co., Canadian Westinghouse Co., and Allis-Chalmers Co. Proposals for Electrical and Air Brake Equipment, 1912) The ERR was familiar with both General Electric and Westinghouse motors but was not familiar with General Electric air brake equipment or any motor or air brake equipment from Allis-Chalmers. In order to try these new equipments, the ERR ordered three sets of motor and air brake equipment from Allis-Chalmers (through its Canadian office, Allis-Chalmers-Bullock), ten sets from Canadian General Electric and twenty-two sets from Canadian Westinghouse. (Allis-Chalmers, Canadian General Electric, and Canadian Westinghouse Contracts for Motor and Air Brake Equipment, 1912-1913)

The Allis-Chalmers equipment, which was installed on streetcars 47 through 49, consisted of four type 301, 40 H.P. (29.8 kW) motors. (ERR Valuation Record, December 31, 1913) These motors were similar in appearance and operation to both the GE-80A and the Westinghouse 101-B motors. The gear ratio that was used with the type 301 motors was 15 to 69 and provided the same motor speed reduction as the gears used with the GE-80A-1 and with the Westinghouse 101-B-2 motors. (Allis-Chalmers Co. Specifications of Type 301 Motor, 1910, p. 3) Two Allis-Chalmers type S-4 controllers, which were similar in appearance and operation to K-6 controllers, were installed in each streetcar in addition to two lightning arrestors near each controller and a single trolley pole which was placed on the roof directly over the rear truck. The air brake apparatus for these streetcars was similar to the Westinghouse

equipment. One Allis-Chalmers type AA-7 air compressor supplied the compressed air for each unit, however, The AA-7 air compressor produced a greater volume of compressed air per minute than the Westinghouse D-1-EG compressor. The AA-7 unit, however, had more moving parts. (Allis-Chalmers Co. Specifications of Equipment, September 1912, and Drawing of S-4 Controller and Wiring Diagram, 1910)

The ten sets of General Electric motors, installed on streetcars 50 through 58 and on streetcar 63, consisted of the same type of motors, controllers and auxiliary apparatus which had been installed on earlier ERR passenger streetcars equipped with General Electric equipment. (ERR Valuation Record, December 31, 1913) The air brake equipment included one C.P. 27-A compressor which was similar in operation to the Westinghouse D-1-EG compressor. The General Electric unit had a different external appearance. (Canadian General Electric Co. Contract for Equipment, January 1913, p. 3)

The twenty-two sets of Westinghouse motor and air brake equipment, which were identical to the Westinghouse equipment installed on other ERR passenger streetcars, were installed on streetcars 59 through 62 and on streetcars 64 through 81. (Canadian Westinghouse Co. Contract for Equipment, 1912, and ERR Valuation Record, December 31, 1913)

All of these Preston built streetcars were equipped with pneumatic sanders operated from the front vestibule, and hand brakes with handles located in both vestibules. It is important to note that "staffless" brakes were installed on these streetcars. (Preston Car and Coach Co. Specifications of Streetcars, November 8, 1912, p. 8) It should be recalled that the older type of handbrake employed a vertical staff with a large handle on the top which was used to apply the brakes. The brakes were held in the "on" position by a large ratchet gear and pawl (dog) which were

located on the floor of the vestibule. If someone accidentally released the dog while the brakes were on, the handle on the brake staff would revolve rapidly, possibly striking someone and causing injury. The staffless brake consisted of a pedestal-like hollow iron casting which was bolted to the vestibule floor. A steel shaft installed horizontally in the casting, and protruding from the casting a short distance, enabled a large handwheel to be attached to it. Through gears attached to the shaft, the action of rotating the handwheel was transmitted to another shaft which supported a spirally-shaped casting to which a chain was attached. In addition, the shaft also rotated a ratchet gear which engaged a pawl that was controlled by a small foot pedal at the base of the casting. The chain passed through the bottom of the casting, over a pulley, and was connected to the brake beam. (Electric Railway Journal, 1911, reprinted in Traction Heritage, September 1975, pp. 37-38) The action of the staffless brake was such that the pawl could not be released unless the handwheel was rotated in a clockwise direction a short distance in order to release the gear pressure on the pawl. Staffless brakes, therefore, reduced the likelihood of accidental brake release and bodily injury. In addition, 12 inch (305 mm) diameter foot gongs were placed beneath the floor of both the front and rear vestibules. (Preston Car and Coach Co. Specifications of Streetcars, November 8, 1912, p. 7)

Delivery of these streetcars, referred to by most ERR personnel as "big Prestons", began in May 1913 with number 47, 48, 49, 51, 52 and 53. Streetcars 50 and 54 through 74 were delivered between June and October. (SRDGL, Account C6A) It appears that each streetcar was sent to Edmonton as it was completed by the builder. It seems likely, therefore, that only nine sets of General Electric equipment were available when streetcars 50 through 59 were completed. This would

explain why streetcar Number 63 (which was delivered in September) instead of Number 59 was the tenth streetcar to be equipped with the General Electric equipment. (SRDGL, Account C6A, and ERR Valuation Record, December 31, 1913) Streetcars 75 through 81 were not delivered until 1914. (SRDGL, Account C6A) In the words of ERR Superintendent W. Woodroofe, "Thirty-five of these cars were ordered, but on account of the traffic not keeping up to expectations, seven cars were left over to be delivered during 1914" (CEAR, 1913, p. 288). The remaining seven streetcars were delivered throughout 1914, the last ones reaching Edmonton in September. (SRDGL, Account C6A) The total weight of each complete big Preston streetcar was approximately 46,000 pounds (20 866 kg), the heaviest streetcars on the ERR at that time. (ERR Diagram of Resistance Wiring for 23 Ton Preston Car, June 1914) The thirty-five big Prestons gave the ERR a substantial surplus in passenger equipment since the maximum number of streetcars usually placed in daily service was approximately fifty-six. (Edmonton Journal, March 20, 1914, to July 31, 1914) There were seventy-nine passenger streetcars available for service between September and December. (SRDMR, January to December, 1914) It would be several years before the ERR purchased additional passenger rolling stock. Plate 27 (Glenbow Archives) shows streetcar Number 73 as it appeared sometime during 1914. The marker lamps, roof ducts, sash mounted sign, single trolley pole and the controller in the rear vestibule should be noted.

Freight and Service Equipment, 1913

It was mentioned in a previous section that passenger streetcar Number 7 had been used as a sand car since 1911. In an earlier chapter, it had also been stated that the streetcar had been fitted with a roof

mounted platform in 1913 to enable it to be used for erecting trolley wires. (See Chapter IV) Evidently, this was a temporary arrangement because in January 1913 the ERR began to construct a service car specifically designed for overhead construction and maintenance. (SRDGL, Account C6B) This vehicle consisted of a plain wooden frame which was strengthened by four underslung truss rods. A wooden deck placed on the frame supported a small wooden cab in the centre which, in turn, supported a wooden platform containing a small central section that could be elevated several inches (mm). (ERR Drawing of Line Car L-1, 1913) Access to the platform was provided by ladders which were placed at both ends of the cab. The placement of the cab in the centre of the frame enabled large spools of trolley wire to be carried easily. In addition, a centre cab enabled the line car to be arranged for double end operation. Two Bemis type 45 trucks supported the line car. These trucks were taken from one of the Preston passenger streetcars 10, 12, 14 or 16. The line car was arranged for double end operation. Trolley poles were placed at both ends of the fixed platform. A K-6 controller was also placed at each end of the cab. (ERR Drawing of Line Car L-1, 1913) Only two GE-80A-1 motors were installed on the line car. (ERR Valuation Record, December 31, 1913) Both motors were placed on one truck, which was a similar arrangement to the motor placement on the Preston sprinkler car. If only one motor were installed on each truck, the trucks would be unbalanced and would tend to derail. The line car was also equipped with a set of Westinghouse straight air brakes in addition to staff hand brakes. (ERR Drawing of Line Car L-1) A General Electric portable arc headlamp was installed on the line car. This headlamp could be hooked onto either end of the frame and received its power from plugs which were mounted on the underside of the frame.

(SRDGL, Account C6B, and Photographs of Line Car in the Provincial Archives of Alberta) It is significant to note that line car L-1 was the first unit of rolling stock which was fabricated by the ERR. (CEAR, 1913, p. 288) Plate 15 (Provincial Archives of Alberta) shows line car L-1 on the High Level Bridge sometime between April and August 1913. The Bemis trucks, platform, the spool of trolley wire and the lack of motors on the rear truck should be noted.

By 1912, the ERR management believed that it was losing freight revenue by not being able to haul large quantities of loose material such as gravel, earth and bricks. In addition, the lack of rolling stock which could haul and distribute large amounts of such commodities severely impeded the ERR's ability to deposit ballast along its temporary track. Horse drawn wagons had been used for this purpose in the past. Each wagon could move only a small amount of ballast at a time since one or two horses could not move heavy loads. (See Chapter III, and Photographs of ERR Track Construction in the Provincial Archives of Alberta) Therefore, in October 1912, the ERR ordered a Simplex differential dump car from the Canadian Car and Foundry Company of Montreal. (Canadian Railway and Marine World, November 1912, p. 572)

This unusual item of rolling stock consisted of a narrow steel frame mounted on two trucks which supported a segmented steel bin which could be tipped towards either side of the frame, thus allowing the contents of the bin to spill onto the ground. (See Plate 28) This type of car was referred to as a differential dump car because the bin could tilt to either side. The segmented steel bin was attached along its centre to the dump car frame by a long hinge. A patented system of levers fabricated by the Simplex Company controlled the bin's position. The sides of the bin consisted of steel doors which were hinged along the

bottom and which were held against the bin at the top by hinged clamps. When the dump car had been loaded and had reached its destination, the crews could adjust the levers so that the doors on one side of the bin opened and the bin tilted towards that side. Gravity would then act upon the contents of the bin, thus dumping them onto the ground. A small wooden cab was placed at one end of the frame to house the electrical controls.

Two heavy-duty freight trucks, manufactured by Canadian Car and Foundry, were installed under the dump car. These trucks, designated Class 110 freight, possessed a 6 foot 6 inch (1 981 mm) wheel base and were fabricated of thick steel bar stock which was riveted together. Trucks constructed to this shape were commonly referred to as "arch bar trucks". Small coil springs placed between the truck bolsters and the side frames provided only rudimentary shock absorption. A narrow board was attached between the journal boxes on each side in order to protect the trucks from accidental blows by rocks or bricks as they were dumped. Heavy cast iron wheels, each with six evenly spaced spokes, were installed on the axles. In spite of the long wheel base, for greater truck stability, the motors were outside hung as they had been on the shorter wheelbase trucks found on the ERR. (Drawing of Class 110 Freight Truck, 1909) A total of four GE-80A-1 motors were installed on the dump car. (ERR Valuation Record, December 31, 1913) They were operated by a single K-6 controller which was located in the cab. General Electric train air brake equipment, in addition to couplers at both ends of the frame, enabled the dump car to move railroad rolling stock with ease and safety. (SRDGL, Account C6E)

The dump car was also equipped with incandescent headlamps on both ends of the cab and a gravity operated sander which deposited sand

on the right hand rail. (See Plate 28) The dump car was painted, lettered and numbered before it was delivered to the ERR. The lettering consisted of the name "Edmonton Radial" placed on the front of the cab and the designation "S-5" placed on both sides and the front of the cab. Although the dump car was constructed as a single end unit, the trolley pole could be swivelled around. In this way, the dump car could travel backwards great distances. Plate 28 (Glenbow Archives) shows S-5 dumping a load of bricks near the site of the Highlands School during 1913 or 1914 after backing along the spur placed on Grace (62nd) Street. (See Chapter III and Map 7)

Several City administrators, in early 1913, believed that an additional sprinkler car was required immediately in order for the ERR to be able to keep the accumulation of filth to a minimum on all the paved streets it traversed. In early April, the City finalized an agreement with the McGuire-Cummings Manufacturing Company for the supply of one "turbine" model sprinkler car. This manufacturer was selected because it agreed to deliver the sprinkler by May 17 when it was thought it would be required. (McGuire-Cummings Manufacturing Co. Contract for Sprinkler Car, April 9, 1913)

The frame of this unit, unlike the sprinkler built by the Preston Car and Coach Company, consisted of steel channels and "I" beams which were riveted together. The liberal use of large "I" beams enabled the builder to dispense with truss rods since they would be superfluous. The tank, which consisted of steel plates riveted together, was 78 inches (1 981 mm) in diameter and was approximately 18 feet (5 486 mm) in length. Its capacity was 5,000 United States gallons (18 927 L). (McGuire-Cummings Co. Specifications of "Turbine" Sprinkler, March 1913, pp. 1-2, and CEAR, 1913, p. 288) Although the tank on this sprinkler car

Plate 28. (Glenbow Archives) Differential Dump Car S-5

Plate 29. (City of Edmonton Archives) Sweeper Number 2 Pulling Weed Killer Car

was wider, it had a smaller capacity than the tank on the Preston sprinkler car. The tank on the McGuire-Cummings unit was secured to the frame with steel bands in a similar fashion to the Preston sprinkler. Canvas covered wooden hoods were installed between the ends of the tank and stanchions placed at the ends of the frame. Metal dashes, placed at each end of the frame, protected the crews and the control apparatus from the elements. (McGuire-Cummings Co. Specifications, p. 2)

The sprinkler was placed on two McGuire-Cummings S-E 60 motor trucks, a type of arch bar truck which resembled the Canadian Car and Foundry Class 110 freight truck. The wheelbase of the S-E 60 truck, however, was 4 feet 6 inches (1 372 mm). The ERR standard 34 inch (864 mm) diameter rolled steel wheels were placed on the axles. (McGuire-Cummings Co. Specifications, p. 3) The sprinkler came equipped with pneumatic sanders, staff hand brakes, 10 inch (254 mm) diameter foot gongs at both ends, and a heavy-duty centrifugal pump and electric motor which was designed to pressurize the tank. (McGuire-Cummings Co. Specifications, pp. 1-3) In addition to sprinkler heads at each end of the unit, a hinged steel arm was attached to the frame of the unit on one side. This arm, which could be swung out towards the curb, held four nozzles which were designed to spray pressurized water as close to the curb as possible, thereby forcing the filth against the curb. (McGuire-Cummings Co. Specifications, p. 2, and Photographs of Sprinkler S2 in Glenbow Archives) The sprinkler was painted and lettered before it was sent to Edmonton. The name "Edmonton Radial" was placed on each side of the tank. In addition, the designation "S2" was painted on either side of the name as well as near the edges on both dashes. (Photographs of Sprinkler S2 in Glenbow Archives) The installation of

motor and air brake equipment took place in Edmonton.

The sprinkler was equipped with four Westinghouse 101-B-2 motors and two K-6 controllers. Current was collected from a single trolley pole placed on top of the tank near its centre. Westinghouse straight air brake equipment was also installed on this unit. (SRDGL, Account C6F, and ERR Valuation Record, December 31, 1913) The older style of rigid fender had to be applied to this sprinkler because there was insufficient room between the extremities of the frame and the front of the trucks to allow the installation of an HB lifeguard which was normally installed on ERR rolling stock. The ERR also equipped the unit with an arc headlamp. (Photographs of Sprinkler S-2 in Glenbow Archives) It is significant to note that Sprinkler S-2 was the final unit of manufactured freight rolling stock purchased by the ERR for use on its street railway. (See Appendix I)

Equipment Modifications, 1913-1914

In June 1913, construction was completed on a new car barn and maintenance facility in Edmonton's Cromdale district, at Beech (117th) Avenue and John (80th) Street. (CEAR, 1913, p. 288) The Cromdale car barns contained several pieces of heavy machinery which were designed to facilitate streetcar maintenance. Part of the machinery included one 42 inch (1 067 mm) wheel turning lathe and one 250 ton (226 800 kg) wheel press. (Woodroofe, 1914, p. 24) These machines enabled the ERR to undertake their own repairs on axles and wheels. The services of the Canadian Northern Railway, therefore, were dispensed with.

The new car barns also included a carpentry area which could accomodate two streetcars at a time and a paint shop with a capacity of six streetcars at a time. (Woodroofe, 1914, p. 23) The new shops enabled

the ERR to undertake extensive repairs on streetcars without disrupting the movement of streetcars through the car barns. Apart from routine repainting and revarnishing, the paint shop was used to add lettering to several passenger streetcars during this period. In an effort to speed the service on the system, the statement "Pay As You Enter" was placed between the numbers located on the streetcars' bunters. In addition, the words "Have Exact Fare Ready" were placed on the exterior body sheathing near the rear doors on some streetcars. (SRDGL, Account T13, and Photographs in the Provincial Archives of Alberta)

The general conversion of the passenger fleet to illuminated signs and marker lamps also continued during this period. (SRDGL, Account T13) In addition, streetcars equipped with the bar type of window guard had them replaced by the same type of wire netting guards that had been supplied with the big Preston streetcars. (CECR No. 211, October 1, 1915) It had been discovered by the ERR that the wire netting was more effective than the bars in preventing passengers from sticking their appendages out of the windows.

In an effort to prevent motormen from wasting expensive electricity by accelerating the controllers too quickly, the ERR purchased and installed automotoneers on many of its streetcars' controllers. (SRDGL, Account T13) An automotoneer was a device which was attached to the top of the controller power shaft and which limited the speed at which the controller could be advanced. The automotoneer consisted of two steel castings, one of which was attached to the top of the controller with screws. This casting contained ratchet teeth around the circumference of its interior. This casting supported another casting which held several centrifugally operated pawls. The upper casting also held the power handle. The operation of an automotoneer was similar to the operation

of a trolley catcher. If the motorman tried to advance the power handle too quickly, the pawls would swing out and would engage the ratchet teeth, thus preventing further advancement of the power handle until the motorman released pressure on the handle. The power handle could, however, be quickly returned to the "off" position since the ratchet teeth held the pawls in only one direction. The automotoneer prevented motormen from advancing the controllers too quickly, thus reducing strains on the motors and gears and reducing the amount of power consumed by the motors. (Doane & Parkham, 1926, § 22 pp. 34-36)

During 1913, gongs were installed beneath the rear vestibules of all single end streetcars on the ERR. (SRDGL, Account T13, Glenbow Archives Photograph ND-1328-1962, and Author's Inspection of Streetcars 13 and 31) These gongs were probably installed as the result of the Y accident in June 1912 which killed a young child who was playing directly behind a single end streetcar and did not hear it approach as it backed into the Y. In addition, the single roof mounted swing bell on the combination baggage/sweeper car was replaced by roof mounted gongs which were placed near each end of the unit. (SRDGL, Account T13, and Photographs in Author's Collection)

In 1914, the ERR experimented with a type of 40 H.P. (29.8 kW) motor which had a much lighter weight than the older types of motors then in use on the ERR. The motor was the GE-67A which was physically smaller than the GE-80A. (General Electric Co. Specifications of GE-67A Motor, 1909, and Specifications of GE-80A Motor, 1910) The GE-67A motor was not a heavy duty motor and was not designed to withstand the loads that could be placed on a GE-80A motor. (General Electric Co. Bulletin 4421A, January 1907, p. 1) Four GE-67A motors were installed on one of the big Preston streetcars in 1914 in an attempt

to reduce the extreme weight of this type of streetcar, thereby reducing the destructive effects on the track and roadbed. (ERR Wiring Diagram of 23 Ton Preston Streetcar with a 4 GE-67A-1 Motors, 1914) The opening of the High Level Bridge in August 1913 meant that several streetcar routes could avoid the steep grades which led to and from the Low Level Bridge. (CEAR, 1913, p. 288)

The smaller size of the GE-67A motor meant that a smaller pinion gear had to be used with this type of motor if the ERR's standard 69 tooth axle gear was to be used. The smaller pinion gear, therefore, contained fifteen teeth. The gear ratio of 15 to 69 was considered the standard ratio for the GE-67A motor. The full classification of this motor was GE-67A-1. (General Electric Co. Specifications of GE-67A Motor, 1909) The K-6 controllers were not altered since their maximum capacity was four 40 H.P. (29.8 kW) motors.

Although the use of the GE-67A-1 motors reduced the weight of the big Preston streetcar, it seems that the motors could not propel the streetcar satisfactorily. The motors were probably removed during 1915 since there were no further references to their use.

The new Cromdale car barns carpentry area undertook the rebuilding of one vestibule on streetcar Number 14 after it had experienced a mishap with a train in late 1913. The rebuilding took several months. (SRDGL, Account F16H) The rebuilt vestibule was somewhat shorter than it had been originally. In addition, the rebuilt vestibule had an extremely narrow letter board while the undamaged vestibule contained a wide letter board. During this repair, Number 14 was converted to single end operation. (Photographs of Streetcar 14 in Glenbow Archives)

Equipment Disposal, 1913

Streetcar Number 23, which was struck by a train in September 1913, could not be repaired economically. A railroad gondola car had broken the side and the intermediate sills as well as most of the window posts. (Photographs of Wreck in Glenbow Archives) The loss of one passenger car was later reflected in the ERR monthly reports. (SRDMR, September 1913 to October 1914, and SRDGL, Account C6A) Although a press report of January 17, 1916 stated that a streetcar "23" had overturned on 97th Avenue on January 16, it is unlikely that the number in that press report is correct. (Edmonton Journal, pp. 1-2) There were no recorded expenditures of any repairs to streetcar Number 23 in 1914 or in 1915. In addition, the ERR had a large surplus of streetcars by the end of 1913, as well as a large deficit. (CEAR, 1913, p. 288) It is most probable, therefore, that streetcar Number 23 was scrapped after its mishap in September 1913.

Freight and Service Equipment, 1914

In the 1913 Annual Report, ERR Superintendent Woodroofe stated, "there is no reason why in future all work cars should not be built by the Department [ERR], and thus keep the labor in the City" (CEAR, p. 288) In order to transport large objects such as boilers and girders within the City, an unmotorized flat car was required. Such a unit, unlike the motorized flat car, could be moved to a location and left there unsupervised for a considerable time while it was being loaded or unloaded. A press report of November 16, 1912 noted that the steel girders for the new Pantages theatre on Jasper Avenue were hauled to the construction site along ERR tracks by ERR motive power. The girders had been placed on steam railroad flat cars, however. (Edmonton Bulletin)

The ERR might have been able to secure additional revenue if it had possessed a flat car of its own at that time.

The construction of a flat car began in January 1914. The unit was completed by June. (SRDGL, Account C6C) No specifications or photographs have been located which provide any indication of the flat car's dimensions. The ERR's ledger, however, indicates that the unit was fabricated of wood with steel truss rods. (Account C6C) It is possible that the flat car was constructed to the same dimensions as the frame of line car L-1 since the drawings for that vehicle include an illustration of a reinforced wooden frame which did not possess a cab. (ERR Drawings of Line Car L-1, 1913)

It also seems likely that two Bemis type 45 trucks supported the flat car since there was no recorded expenditure for trucks. (SRDGL, Account C6C) In addition, the destruction of streetcar Number 23 in 1913 released a pair of Brill 27-GE-1 trucks for use. It should be remembered that the ERR had found the Bemis trucks unsatisfactory for passenger streetcars because of their rough riding qualities. It is highly probable that the ERR removed a pair of Bemis trucks from a passenger streetcar and replaced them with the surplus set of Brill trucks. The flat car was equipped with a brake cylinder, air hoses and couplers at both ends. (SRDGL, Account C6C) Service units S-4 and S-5 were probably used to move the flat car along ERR lines.

Freight and Service Equipment, 1915

During 1914, the ERR secured a contract for the transportation of mail between the post offices in Edmonton. (CEAR, 1914, pp. 54-55) It is probable that streetcar Number 7 was used for this purpose since it had been used for track sanding, overhead construction and similar

work in the past. By May 1915, the Street Railway Department's Monthly Report no longer listed a sand car but listed an additional work car. (April-June 1915) It seems likely that the ERR had decided that a sand car was no longer required and that the single truck streetcar Number 7 was relegated to general work and service tasks.

Equipment Modifications, 1915-1924

Several trolley catchers were purchased during 1915 which were manufactured by the Earll Company of York, Pennsylvania. (CECR No. 211, October 1, 1915) These catchers, which were installed on several passenger streetcars, did not fail in service and were retained. Economic constraints prevented the ERR from equipping all of its rolling stock with this brand of catcher until the mid 1920's. (Letter to the Dominion Insulator & Manufacturing Co. from ERR Superintendent R. Colwell, November 14, 1924) It is of interest to note that some of the original Earll catchers remained in service until the end of street railway operations in September 1951. (Earll Trolley Catcher in Author's Collection)

The ERR had experienced considerable difficulty with the maintenance of the exterior finish on many of their passenger streetcars. Whenever the protective varnish wore away, the oil paints beneath had tended to lighten unevenly and to smear, giving the streetcar a shabby appearance. The ERR, because of financial constraints, found it difficult to keep the protective varnish coating in good repair on most of its streetcars. In consequence, the ERR decided to experiment with other types of paints and paint pigments that would resist weathering better than the metallic pigments that were found in the dark green and red paints then in use. ERR paint crews determined that the colors yellow and brown to be most resistant to weathering. The brown paint was

to be applied to areas of the body and vestibules below the belt rail while the yellow paint was to be applied to the areas between the belt rail and the roof. In addition, extraneous gold lines and crests were to be dispensed with. (Edmonton Journal, September 24, 1915, p. 3) In this paint scheme, the roofs of the streetcars were to be painted white. (Edmonton Bulletin, June 1, 1926, p. 9) The lettering used with this paint scheme consisted of the abbreviation "E.R.R." which was centred on the letterboards on each side of the streetcar. The numbering consisted of a single number which was centred on each side of the body sheathing. (City of Edmonton Archives Photographs, and Photographs in the Author's Collection) A natural ochre was used by the ERR paint crews to fabricate the yellow paint. (SRDGL, Account T13) The ochre was thought to resist weathering better than metallic pigments. (Edmonton Journal, November 24, 1915, p. 1) The brown paint resembled Pantone ink shade 462C while the yellow paint resembled Pantone ink shade 123C. (Paint Fragments in the Author's Collection, and Pantone Matching System Book, 1980)

Four streetcars were painted in this livery by the end of 1915. (Edmonton Journal, November 24, 1915, p. 1) Streetcars 8, 18, 27 and 29 were repainted during 1916. (CECR No. 176, August 15, 1916) Most of the passenger streetcars were repainted in this livery by 1926.

By 1917, the ERR and the City were experiencing extreme financial difficulties. The situation was so acute that the ERR management had to apply to the City Council in order to receive funds for replacement spur gears for some of the motors. (CECR No. 160, August 27, 1917) In an attempt to reduce operating costs, the ERR began to convert some of their streetcars to one man operation beginning in April 1917. (Edmonton Bulletin, April 18, 1917, p. 3) It should be remembered that a crew

of two men, a motorman and a conductor, had travelled with each streetcar in regular service in the past. The conductor normally had travelled in the rear vestibule and was responsible for fare collection and for the issuing and collection of transfer slips. One man operation entailed the motorman undertaking the conductor's duties as well as retaining his own duties. It was not possible for the motorman to collect fares from the rear vestibule since the streetcars were operated from the front vestibule. In order to facilitate one man operation, the streetcars had to be modified. Before the ERR could undertake extensive conversion to one man operation, permission had to be obtained from the BRC. The BRC gave its approval to the ERR for one man operation by April 17, 1917. (Edmonton Bulletin, April 18, 1917, p. 3)

Fare collection had to take place in the front vestibule since passengers would both enter and leave the streetcar through the front vestibule. The old PAYE system in the rear vestibule could no longer be used. To prevent passengers from using the rear doors, the ERR installed boards across the centre of the doors on the exterior and removed the rear steps. Initially, several streetcars were temporarily converted to one man operation in this manner, with the fare box being installed in the front vestibule adjacent to the motorman. In the meantime, the ERR was engaged in reconstructing several streetcars so that they would be better equipped for one man operation than the temporarily converted streetcars. (Edmonton Bulletin, April 18, 1917, p. 3, and Edmonton Journal, October 11, 1917, p. 1)

One of the ERR's innovations during this period was the creation of a double tread step in which the lower tread folded up by means of levers as the door was being closed. The double step reduced the distance an individual had to lift his or her foot in order to board the

streetcar. (Canadian Railway and Marine World, March 1917, p. 113) The double step consisted of shaped steel hangers to which were bolted the upper wooden tread; the lower tread was hinged to the step riser. (See Plate 25) The lever mechanism used for raising and lowering the bottom tread had been adopted from the folding step mechanism which had been supplied with the fifteen St. Louis built streetcars. (St. Louis Car Co. Drawing of Folding Door and Step Mechanism, 1912) A vertically aligned steel pipe, which was placed in the front vestibule to the right of the motorman, was attached to two levers in addition to an operating handle. One of the levers opened and closed the folding door which was installed to the right of the motorman, while the other lever raised and lowered the folding tread in conjunction with the opening and closing of the folding door. The City Commissioners had expressed concern that the ERR may have infringed upon patents by using this type of mechanism with their double tread step. (Canadian Railway and Marine World, March 1917, p. 113) No litigation appears to have occurred and the step mechanism remained unaltered.

The ERR selected double end streetcars for conversion to one man operation since the ERR wished to install double-width folding doors on the right-hand side of the front vestibules in order to retain a type of PAYE system and to speed loading and unloading of passengers at each stop. In the conversion process, the single-width sliding door was removed and was replaced by a double-width folding door. A series of stanchions placed inside the vestibule guided entering passengers to the right where they paid their fares as they passed by the motorman. Exiting passengers used the left-hand half of the doorway. The front bulkhead had to be modified in order to accommodate this arrangement. A double-width opening was made in the bulkhead adjacent to the right-hand

vestibule doors. The bulkhead door adjacent to the left-hand vestibule doors was replaced with a wood and glass panel. (ERR Drawing of Front Bulkheads) The rear vestibule was also modified. All of the entrance and exit doors, with the exception of one single-width door, were made inoperable. The single-width door was designed for emergency use only and was controlled by the motorman through a system of levers that ran underneath the frame of the streetcar. Several streetcars that were converted in this fashion were changed from double end to single end streetcars. In the case of such a conversion, one of the trolley poles and its base would be removed. In addition, rattan-covered seats were placed around the sides of the rear vestibule in order to provide additional seating. A small section of the seat, which was located directly in front of the emergency exit, was hinged and attached to the lever that operated the emergency door. When the emergency door was opened, the seat was supposed to swing up and out of the way of the emergency exit. (Edmonton Bulletin, June 9, 1917, p. 3) The rear bulkhead was unaltered since it was intended to isolate the rear vestibule from the streetcar body. Smoking was to be allowed in the rear vestibule. A mirror mounted inside the front vestibule enabled the motorman to observe the passengers inside the streetcar. (Edmonton Bulletin, June 9, 1917, p. 3)

The first streetcar to undergo extensive conversion to one man operation was Number 16, which was also converted to single end operation. This streetcar made its first run as a one man streetcar on June 8, 1917. (Edmonton Journal, June 8, 1916, p. 2) The car had been selected for conversion primarily because it had been involved in a mishap which damaged both vestibules. (Edmonton Bulletin, June 9, 1917, p. 3)

The ERR intended to convert all of its St. Louis built streetcars

to one man operation because they possessed longer vestibules. A press report of June 12, 1917 noted that several motormen objected to this plan because they claimed that the St. Louis built streetcars were the coldest on the ERR and that it was likely that they would be colder in future. The motormen claimed that the heaters would be unable to keep the vestibules warm since the vestibules had not been warm in the past and would probably be colder with the installation of double-width doors. (Edmonton Bulletin, June 12, 1917, p. 3) In spite of these complaints, streetcars 32 through 46 were converted to one man operation. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, February 18, 1926) It should be noted that only ten of the series (33-35, 37, 40-45) were converted to single end operation. (SRD Table of Car Weights and Levers, circa 1920) The five St. Louis built cars that were left as double end units had double-width doors installed in both vestibules. It should be noted that these streetcars did not have provision for smokers. (Letter to ERR Superintendent W. J. Cunningham from the City Commissioners, June 7, 1926) Seventeen one man streetcars were operating by October 1917 but most of these consisted of streetcars that had been temporarily converted for that purpose. (Edmonton Journal, October 17, 1917, p. 1)

At least one other double end streetcar was converted to single end one man operation during this period. A photograph of streetcar Number 12 taken in September 1919 indicates that it had been converted to single end operation. It is of interest to note that Number 12 had not been repainted and, therefore, did not appear to be in good repair. (Glenbow Archives Photograph ND-3-279) It appears that no double end streetcars with short vestibules or single end streetcars were fitted with double-width front doors during this period although the ERR abandoned

two man operation by the end of 1920. (SRDAR, 1920, p. 2, and Photographs in City of Edmonton Archives) It was not too difficult for the ERR to install double-width doors on most streetcars that had been built for double end operation since these units possessed longer vestibules which could accommodate double-width doors. In order for the ERR to have installed double-width front doors on streetcars with short front vestibules, the vestibules would have had to be lengthened and completely rebuilt. The ERR was unwilling to undertake this difficult and costly task. Several photographs from this period depict streetcars with the double tread step, including some of the big Preston streetcars. None of the units so equipped possessed double-width front doors. (Photographs in City of Edmonton Archives and Photographs in Glenbow Archives) In addition, the ERR sold several surplus big Preston streetcars during this period. This type of streetcar was selected for sale because the ERR management felt that it would be too difficult to alter these streetcars for proper one man operation. (Edmonton Bulletin, July 6, 1917, p. 1)

It appears that the ERR was able to install the double tread step on streetcars that did not possess double-width front doors. On streetcars equipped with double-width doors, a single tread fixed step was installed. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, February 18, 1926) It should be noted, however, that a single tread folding step was installed beneath the emergency exit. (Glenbow Photograph ND-3-279) It is likely that the step was lowered by the same lever arrangement which opened the emergency door and which raised the seat in front of the door. It is probable that the double-tread step could not be used with double-width folding doors because the extreme length of the treads would enable the folding tread to sag in

the centre.

The streetcars that had single-width front doors were gradually fitted with folding doors, if they were not already equipped with them, and were fitted with the double tread folding step. By the end of 1925, forty-four of the ERR's seventy-two operable passenger streetcars were equipped with the double-tread folding step. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, February 18, 1926)

During this period, the ERR replaced many wheels as they wore out. The ERR standard passenger streetcar wheel had been a rolled steel wheel with a diameter of 34 inches (864 mm). Rolled steel wheels were expensive compared to other types of wheels that were used by other street railways. One type of wheel that was less expensive was fabricated from cast iron. Several cast iron wheels were purchased and installed on several streetcars during this period. (SRDGL, Account T13) It should be recalled that the first fourteen ERR streetcars had been originally equipped with cast iron wheels. It should also be remembered that they had been replaced with rolled steel wheels because the cast iron wore down quickly. The type of cast iron wheel that was obtained at this time, unlike the cast iron wheels used in the past, were 34 inches (864 mm) in diameter and were of heavier construction. The new wheels contained nine spokes whereas the original wheels had possessed only six. (ERR Drawing of Cast Iron Wheels, 1915) Rapid wear was still a problem with the new cast iron wheels. In consultation with the Toronto and York Radial Railway (T&YRR) of Toronto, Ontario, the ERR became aware of a method whereby the use of cast iron wheels could be prolonged. (T&YRR Drawings of Steel-Tired Wheels, December 1913)

When the flange of a cast iron wheel became too thin, the wheel was turned on a wheel lathe until the circumference was reduced to

a specific diameter. A commercially fabricated flanged steel tire, which was heated in the shop, was then placed around the cast iron wheel. As the tire cooled, it shrank onto the cast iron centre, gripping it tightly. This type of steel-tired wheel was installed on several ERR passenger streetcars beginning in 1916. (ERR Drawing of Steel-Tired Wheel, 1915) The steel tire prolonged the usefulness of the cast iron wheel.

The installation of cast iron and steel-tired wheels on ERR rolling stock ceased during 1925 when the ERR re-adopted the rolled steel wheel as its standard streetcar wheel. (SRDAR, 1925, p. 2 and ERR Drawings of Standard Streetcar Wheel, 1928)

Between 1915 and 1924 the roof mounted signs on streetcars equipped with them were removed. The marker lamps were left in place. (Glenbow Archives Photographs) Edmonton had abandoned its system of named streets in favor of numbered streets. In addition, the ERR had begun to refer to routes by dash mounted colored signs and lamps only, dispensing with the use of displayed destination names. (Canadian Railway and Marine World, August 1919, p. 448, and Current Flashes, July 15, 1921, pp. 1-2) The illuminated signs, therefore, were no longer required.

After the end of the First World War, the ERR began to replace the arc headlamps then in use with dash mounted incandescent headlights of a similar design to the incandescent headlights used between 1910 and 1912. The new incandescent headlights were designated "type Z" and were manufactured by the Crouse-Hinds Company. (SRDGL, Account T13, Photographs in City of Edmonton Archives and Artifacts in Author's Collection) The arc headlights were removed because their extremely bright light had tended to dazzle motorists, preventing them from seeing the road and any obstacles in their way. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, August 5, 1926)

This was the fourth time that the ERR had changed the type of headlights in use on streetcars since 1908. The change from arc headlights to incandescent headlights was brought about by the increase in motor vehicle traffic following the end of the First World War. The apparatus used by the ERR was frequently altered by external technologies. Other examples of this phenomenon will be discussed in subsequent sections.

By 1919, the ERR had begun to alter the interior passenger signal systems found in streetcars so that either an electric bell or a hammer gong was located in the front vestibule. With the cessation of two man operation, the bells in the rear vestibules were no longer required, so they were removed. (Canadian Railway and Marine World, April 1919, p. 204)

It appears that the ERR dispensed with the use of automotoneers during this period since ledger entries for the acquisition of automotoneer parts cease by the end of the First World War. (SRDGL, Account T13) It is probable that the automotoneers were discontinued because of their apparent continual need for parts and repair.

Equipment Disposal, 1917

On June 13, a broken trolley wire fell onto the roof of streetcar Number 22 as it was travelling south along 109th Street. The wire touched the smoke stack of the heater which created a short circuit. The resulting sparks and heat started a fire which consumed the entire body of Number 22. The fire was extinguished before it destroyed the frame and the trucks. Although the body of the streetcar had been destroyed, both the frame and the trucks were pulled back to the car barns where they were retained for the possible rebuilding of the streetcar. (Edmonton Journal, June 14, 1917, p. 12)

It has been mentioned previously that there was a surplus of passenger streetcars on the ERR as early as 1914. The ridership on the ERR had not improved substantially by 1917; and with the acute financial situation, the City decided to sell some of their surplus streetcars. It has also been mentioned that the big Preston streetcars were selected for sale since they could not be fitted with double-width front doors without extensive vestibule reconstruction. In July, the City sold streetcars 80 and 81 to the Oshawa Street Railway Company through equipment broker D. M. Campbell, formerly the General Manager of the Preston Car and Coach Company, now defunct. The two streetcars were sold complete with motors and air brake equipment. (SRDGL, Account C6A, and Edmonton Bulletin, July 6, 1917, p. 1)

Equipment Disposal, 1918

The City continued to dispose of surplus ERR rolling stock. Two additional big Preston streetcars, 50 and 58, were sold. They were purchased through D. M. Campbell by the T&YRR. (SRDGL, Account C6B) The destruction of several T&YRR streetcars in a car barn fire earlier in the year prompted that street railway to purchase the Edmonton streetcars. (Canadian Railway and Marine World, September 1918, p. 404)

The differential dump car S-5 was also sold. The dump car had been used primarily to haul bricks to the site of the Highlands School. The unit was not used much after the completion of the school building. In addition, most freight hauling assignments could be undertaken by the versatile motorized flat car. The ERR, therefore, deemed S-5 surplus and the unit was sold to D. M. Campbell. (SRDGL, Account C6G) The ultimate disposition of the dump car is not known.

At some point during 1918, streetcar Number 2 was involved in

a mishap with a train at a level crossing. The damage to Number 2 was extensive enough so that the ERR did not consider it economical to repair the unit as a passenger vehicle. The ERR did use the frame and trucks from Number 2 when they fabricated a new sweeper car. (SRDGL, Account C6C)

Freight and Service Equipment, 1918

The previous section mentioned that the frame and the trucks of streetcar Number 2 were used as part of a new sweeper car. This unit, which was completed by November, was a single end sweeper. The body frame, without the vestibules, supported a wooden deck and a cab which was placed in the centre of the frame. The cab contained a heater in addition to the controllers and the air brake valve. A broom assembly taken from the McGuire-Cummings sweeper was placed at one end of the frame. A truss assembly along the left-hand side of the cab near the roof supported the end of the broom assembly. A small wooden box placed in front of the cab enclosed the broom motor and protected it from the elements. (SRDMR, June-December 1918, and Plate 29) Plate 29 (City of Edmonton Archives) shows the ERR built sweeper sometime during the early 1930's. The truss rod leading from the cab roof should be noted. The small vehicle behind the sweeper is former passenger car Number 7. Its condition will be described in a subsequent section.

The combination baggage/sweeper car that was in use from 1909 was converted to single end operation during 1918 since one of its broom assemblies was installed on the sweeper described above. With most ERR lines equipped for single end streetcars, several double end sweepers were no longer required. In addition, by converting the baggage/sweeper car to single end operation, the ERR was able to equip an additional

sweeper at a very low cost. The additional sweeper enabled the ERR to improve the rapidity with which snow was removed from their lines.

During this period, line car L-1 underwent some modification. The roof-mounted platform, which appeared to be too high for crews to work on the overhead wires comfortably, was removed. (See Plate 15) The platform was replaced by a wooden tower arrangement which was similar in construction and operation to the tower on the tower wagon. (See Plates 13 and 17) The new line car tower was somewhat larger than the tower on the tower wagon. In order to accommodate the larger tower on the line car deck, the cab was moved several feet (mm) towards one end of the frame. The tower was then placed on the deck behind the cab. A running board was placed along the centre of the cab roof. Current collection was accomplished by a single trolley pole which was installed on the centre of the cab roof. A Glenbow Archives photograph shows the line car in its modified form towards the end of 1918. (NC-6-5179) It is likely that the line car was operated as a single end unit from this time since the wire reels could be placed at only one end of the line car.

Equipment Disposal, 1919

The ERR passenger fleet was reduced by one streetcar on October 27 when streetcar Number 21, travelling east along 102nd Avenue, derailed while crossing a bridge near 132nd Street and overturned into the ravine below, destroying its body and frame. It was fortunate for the passengers that the front truck fell into the ravine before the body did. In addition, the kingpin holding the rear truck sheared as the body overturned, so the rear truck remained on the track. No passengers were killed in this mishap but the impact of the crash not only demolished the sides

of the streetcar, it bent both needle beams as well. (CECR No. 227, October 27, 1919, and Photographs of Mishap in City of Edmonton Archives)

Passenger Equipment, 1919-1920

The destruction of Number 21 in October meant that another double end streetcar had to be assigned to the 102nd Avenue line since that track had no facilities for turning single end streetcars. That particular line had never been heavily used and had been unremunerative since it had been built. (Edmonton Official Gazette, April 9, 1914, p. 6) In an attempt to reduce the operating costs of that streetcar line, the ERR assigned streetcar Number 7 to it. It should be recalled that Number 7 had not been used for passenger service for several years because of its small size and its lack of air brakes. Number 7, however, was well suited to the 102nd Avenue line since it was practically flat and because it did not have a heavy ridership. In addition, that streetcar possessed only two motors so power consumption and, therefore, operating costs were reduced. Number 7 remained in service on the 102nd Avenue line until 1927 when it was removed from passenger service yet again. (Edmonton Journal, June 8, 1929, p. 20)

As early as 1914, the ERR management had discussed the possibilities of operating a sight-seeing car on the street railway. (Edmonton Journal, December 30, 1914, p. 1) The Calgary Municipal Railway had been operating a commercially built sight-seeing car since 1912 and it had become a popular feature in that City. (Canadian Railway and Marine World, July 1912)

In 1914, the ERR did not have the financial means to purchase a sight-seeing car. In addition, the First World War severely reduced

the population in Edmonton. Plans for a sight-seeing car were, therefore, postponed until after the end of the War. A previous section mentioned the destruction of streetcar Number 22's body by fire in 1917. In 1919, the ERR began the construction of a sight-seeing car using the frame and the trucks from streetcar Number 22. (SRDGL, Account C6C) It seems probable that the ERR used the Calgary sight-seeing car as a model for a similar vehicle since there was a marked physical similarity between the two cars. (Glenbow Archives Photographs of Calgary Sight-seeing Car, and Plate 30)

The entire frame of Number 22 was used, including the vestibules. A curved wooden dash was attached to the end of the front vestibule. The floor was arranged in tiers, ascending from the front vestibule. The tiered floor was enclosed by decorated wooden sides. A staircase installed near the back of the floor enabled passengers to descend to the rear vestibule. Twenty-one wooden slat cross seats were placed on the floor which gave the vehicle a seating capacity of forty-two passengers. (Edmonton Journal, June 30, 1920, p. 6, and Plate 30) Wire netting was placed along the left-hand side of the car above the wooden sides in order to prevent passengers from sticking their heads or arms out. Unlike the Calgary unit, the ERR's sight-seeing car possessed a canvas-covered wooden arch roof, in addition to a small windshield which was placed between the front dash and the bottom of the roof. A roof mounted headlight, which was taken from one end of the combination baggage/sweeper car, illuminated the track ahead of the unit when it was dark. (City of Edmonton Archives Photograph of Combination Baggage/-Sweeper Car, and Plate 30)

The sight-seeing car, referred to as the "observation car" by ERR personnel, was completed in June 1920 and was placed in service on

July 1. (SRDAR, 1920, p. 1) The observation car was painted white above the trucks. The panels in the sides of the unit were painted gold with red trim. The only lettering consisted of the abbreviation "E.R.R." which was painted in gold on the front of the dash. (Edmonton Journal, June 30, 1920, p. 6) Plate 30 (Provincial Archives of Alberta) shows the appearance of the ERR's observation car sometime during the early 1920's. The wire netting along the left-hand side should be noted.

The observation car was used regularly during the summer months until the end of 1925. In 1926, the ERR discontinued regular observation car service for two reasons. Firstly, the revenue earned did not offset operating costs; secondly, the observation car could not stop for long periods in the central part of Edmonton to load passengers since it impeded regular streetcar service. (Edmonton Bulletin, February 16, 1926, p. 10) The observation car was used for special excursions between 1926 and 1935, at which time it was retired and stored at the Cromdale car barns. (Electric Railway Statistics, 1926-1936, and Photographs by R. J. Walker) The observation car remained extant until 1945 when it was stripped of all useable parts and destroyed by the ETS. (Photographs by R. J. Walker and E. Smith)

Equipment Disposal, 1922-1927

By the early 1920's, many residents of Edmonton no longer used a horse and carriage as their personal means of transportation. Various types of motor vehicles were used instead. In addition, the increased use of the motor truck meant that many mercantile establishments abandoned the use of horses. It should be noted that horses were costly to keep since they required daily feeding whether they were used or not; and they required heated shelter in winter. The diminished use

Plate 30. (Provincial Archives of Alberta) Observation Car

Plate 31. (Author's Collection) Streetcar Number 84

of the horse in Edmonton meant that the amount of manure deposited on the City streets was reduced. The City, as well, had begun to purchase sprinkler trucks in 1913 to replace the horse-drawn sprinkler wagons that had been in use. (Glenbow Archives Photograph NC-6-597) The sprinkler trucks were more versatile than either the older sprinkler wagons or the ERR sprinkler cars. The trucks could travel along any street whereas the sprinkler cars could not. In addition, the trucks possessed motor-driven pumps that sprayed water with as much force as the sprinkler cars did. The increased use of the automobile, coupled with the introduction of sprinkler trucks, made the ERR sprinkler cars obsolete.

At the end of the 1921 sprinkling season, the ERR retired the Preston sprinkler car. Crews removed the tank and sold it locally in April 1922. (SRDGL, Account C6) The frame was stripped of its electrical gear and was placed in storage on an outside track near the Cromdale car barns. (Glenbow Archives Photograph NC-6-11154)

Sprinkler S2 (the McGuire-Cummings unit) was retained in serviceable condition until late 1924 when its tank was removed and sold. (SRDGL, Account C6) It should be noted that the last time S2 sprinkled or flushed any streets was during October 1922. (SRDMR, October 1922-December 1924) The frame of this sprinkler was also retained for later use.

The unmotorized flat car was retired and disposed of in early 1922. (SRDMR, January-September 1922) It is probable that the flat car had not been used much following the end of the First World War because of the emergence of large capacity motor trucks.

In December 1927, streetcars 3 and 7 (both built in 1908) were retired because they were in poor condition. Superintendent Cunningham was of the opinion that it was not worth the expense to rebuild these units. (SRDMR, January 1928, Letter to Commissioner D. Mitchell from

SRD Superintendent W. J. Cunningham, April 8, 1929, and Edmonton Journal, June 8, 1929, p. 20)

Freight and Service Equipment, 1922-1929

It was described in a previous section how the Preston sprinkler was retired and stripped during 1922 and was placed in storage. In Chapter III it was mentioned that in 1922, the ERR received permission from the BRC to connect their track on 97th Avenue to a railroad spur which led to the City Power Plant. (BRC Order No. 32036, January 23, 1922) Furthermore, the ERR constructed that interchange in order to receive railroad hopper cars laden with coal cinders. The cinders were to be used as ballast on unpaved sections of ERR track. (Canadian Railway and Marine World, March 1922, p. 150) Although the hopper cars could deposit the cinders along the track, they could not distribute them evenly. A vehicle with a blade at the end as well as a blade at the side was required for this purpose. It seems probable that the combination baggage/-sweeper car was used for ballast spreading initially since it possessed a blade along one side. The unit, however, was not designed to spread ballast and it could not be used for this purpose when it was required for the dispatch of freight. Therefore, the ERR constructed a ballast spreader car using the frame of the Preston sprinkler. (Photographs in Author's Collection) The ballast spreader consisted of a large wooden blade which was mounted at one end of the frame. The blade was installed at a 45° angle facing the right-hand side. In addition, the height of the blade above the rail could be controlled by two steel cables which were attached to a winding shaft which was mounted on the wooden deck placed on the frame. Another wooden blade, placed along the right-hand side of the frame, was hinged along one end and was used to spread

the ballast along the sides of the track. The free end of this blade was supported by a steel wire which was held by a jib arrangement mounted on the deck. A small wooden cab, which resembled the cab of the line car but was smaller, was placed near the end of the frame which held the blade. The cab contained the controller and the air brake valve. A smoke stack is not visible in photographs of this unit so it is unlikely that it possessed a heater. (Photographs in Author's Collection) It is probable, therefore, that the ballast spreader was not used during winter months. The ballast spreader car, which was numbered 5, was placed in operation by September 1922. (SRDMR, January 1921-December 1923)

In 1925, the frame and the trucks of sprinkler S2 were used by the ERR as part of a wrecking car. The ERR constructed a wooden body which resembled the body of the combination baggage/sweeper car and placed it on the sprinkler frame. (SRDAR, 1925, p. 2) The body, which was constructed for double end operation, held a single trolley pole (on the centre of the roof) which could be swung around when it was desired to change the direction of travel. The body was equipped with a heater in order that the unit could be operated during winter. (Photographs in Author's Collection)

The purpose of the wrecker car was to assist any other ERR rolling stock that became disabled for any reason. (SRDAR, 1925, p. 2) The wrecker car, which was numbered 6, was equipped with: lifting jacks, car replacers (tapered castings which guided a derailed wheel back onto the rail), chains, steel cable, trolley poles, journal box packing, grease and miscellaneous tools. (Letter to Commissioner D. Mitchell from SRD Superintendent W. J. Cunningham, November 15, 1926)

In 1928, the SRD refurbished and repainted all three sweepers.

(SRDAR, 1928, p. 2) It is probable that the numbers on sweepers 2 and 3 were reversed at this time.

The body, electrical equipment and the vestibules were removed from former streetcar Number 7 during 1929. A large steel tank, in addition to a wooden deck, was mounted onto the frame. The tank was probably a surplus item from the Cromdale car barns boiler replacement of 1925. (SRDAR, 1925, p. 4) A pump, which had been salvaged from one of the sprinkler cars, was also installed on the deck. Through a system of pipes, the pump pressurized the contents of the tank. Three perforated pipes were installed on the unit so that they hung over one end of the frame. The purpose of this unit was to spray a toxic liquid over the area of unpaved tracks in order to reduce weed growth. Warning lights were mounted beneath the frame to warn individuals of the hazardous spray. (See Plate 29) The "weed killer car" was unpowered and had to be pulled by some other unit of rolling stock. The hand brake was left intact, however, but the brake handle was replaced by a horizontally-mounted wheel. Electric power for the pump and the warning lights was provided by an electrical cable which was connected to the weed killer car at one end and to the towing vehicle at the other end. Plate 29 (City of Edmonton Archives) shows the weed killer car being pulled by the ERR built sweeper sometime during the early 1930's. The tank, pump, pipes and lights should all be noted.

Equipment Modifications, 1925-1930

Beginning in 1925, the ERR embarked upon a program to improve the operation of their passenger streetcars. (SRDAR, 1925, pp. 2-3) It was noted in a previous section that the ERR's plan of installing double-width front doors on their streetcars was halted by the extensive

modifications required for short single end vestibules. In addition, it was mentioned that the ERR had experienced difficulty with the installation of their double tread folding steps on streetcars equipped with the double-width front doors. In order to overcome these difficulties, the ERR abandoned the use of double-width front doors. Streetcars that had been equipped with double-width front doors eventually had them replaced by single-width folding doors and the double tread folding step. (Letter to the City Commissioner from ERR Superintendent W. J. Cunningham, February 18, 1926) The interior vestibule space in streetcars with short front vestibules was extremely limited. This condition caused crowding and reduced the speed at which these streetcars could be loaded and unloaded. Two types of vestibule modification were introduced to alleviate this condition. In wooden-frame streetcars where the bulkhead was an integral part of the substructure, a wider opening was made in the bulkhead adjacent to the front door. In the big Preston streetcars which had steel frames, the bulkhead was more ornamental than functional. As each big Preston streetcar was overhauled, the front bulkhead was moved towards the rear of the streetcar by approximately 18 inches (457 mm). This distance was probably selected because the bulkhead placed in this position vertically bisected the first body window along the left-hand side. That particular window was reformed into two smaller windows on either side of the bulkhead. In addition, the new placement of the bulkhead did not reduce the seating in the body. The large opening in the right-hand side of the bulkhead made the partitioning of the first body window on that side unnecessary.

Changes to the interior lighting of the streetcars were made during this period. The older arrangement of three lines of bulbs along the ceilings was abandoned in favor of a single line of bulbs along the ceiling.

By using bulbs of higher intensity, the ERR believed that higher light levels and a more even distribution of light throughout the interior was achieved. (Letter to F. T. Fisher from the City Commissioners, December 29, 1926)

Besides adopting a standard interior lighting configuration for its passenger streetcars, the ERR standardized the placement of the Peter Smith heaters as well. In the past, some passenger streetcars had the heater installed inside the body while other streetcars had the heater in one of the vestibules. It was discovered that the placement of the heater within the car body meant that the front vestibule became extremely cold in winter. In addition, with one man operation the motorman could not tend the fire easily if the heater was located behind the front bulkhead. (CECR No. 9, February 13, 1928) The ERR placed the heater of each passenger streetcar in the front vestibule in the case of a single end car, and in one of the vestibules in double end streetcars. (Photographs in Glenbow Archives, and Photographs in Author's Collection) The duct work of the heater was extended into the rear or opposite vestibule in order to provide heat to those locations. (Letter to the City Commissioners from SRD Superintendent T. Ferrier, December 24, 1936)

A new type of warning signal was installed on most of the ERR rolling stock during 1925. In the past, pedestrians and vehicles had been warned of streetcars' maneuvers by means of foot gongs which were mounted beneath the floors of the vestibules. With increased use of the automobile, the noise of the gong was frequently obscured so the ERR investigated the possibility of using some other warning device. Several Canadian street railways had installed small air operated whistles on their streetcars in the past. These whistles could be heard above most street noises. (Letter to ERR Superintendent W. J. Cunningham

from the Calgary Municipal Railway, March 25, 1925) By the end of July 1925, the ERR had decided to equip its rolling stock with air operated whistles. The whistles, which were cylindrical in shape, were manufactured by the Canadian Westinghouse Company. (Letter from Canadian Westinghouse Co. to ERR Superintendent W. J. Cunningham, July 23, 1925)

The installation of the whistles was a fairly simple operation. In the vestibule, a short length of pipe was connected to the air pipe which led to the air brake valve. The short pipe was attached to a small spring valve which was located between the controller and the brake valve. Another pipe was connected to the valve. This pipe, on most passenger streetcars, extended down through the vestibule floor where the whistle was attached to it. (Author's Observations, and Photographs in the Author's Collection) On most freight and service rolling stock, the whistle was placed adjacent to one of the forward-facing cab windows, well above floor level. (Photographs in Author's Collection) By early 1926, most streetcars had the air whistles installed. (Letter to ERR Superintendent W. J. Cunningham from Superintendent of Canadian National Railways, March 17, 1926)

In 1926, the ERR also began the final conversion of the passenger fleet to the double-tread folding step which was introduced some years earlier. At this time, streetcars 32 through 46 underwent the additional conversion from double-width doors to single-width folding doors. (Letter to the City Commissioners from ERR Superintendent W. J. Cunningham, February 18, 1926) A new paint scheme was adopted by the ERR in 1926.

On June 1, streetcar Number 77 appeared in service in a red, ivory (cream) and black livery. (Edmonton Bulletin, June 1, 1926, p. 9) The

new color scheme was considered by many citizens to be more esthetically pleasing than the former brown and yellow scheme. (Edmonton Journal, June 2, 1926, p. 13) In addition, the paints used in the new color scheme were modern enamels which did not require a protective coating of varnish. (Letter to the ERR from Pratt & Lambert Inc., September 4, 1930) The red, which was applied to the exterior sheathing below the belt rail, resembled Pantone ink shade 221C. The ivory, which resembled Pantone ink shade 486C, was applied between the belt rail and the roof. (Color Fragments in Author's Collection, and Pantone System Matching Book, 1980) Both the roofs and the trucks were painted black. (Edmonton Bulletin, June 1, 1926, p. 9) The name "Edmonton Radial Railway" was dropped and no lettering was placed on the streetcar. The car number in gold or yellow was placed near each end of the body sheathing on each side of the streetcar, however. The number in black was also placed on the letterboard at each end of the streetcar, centred above the middle window of the vestibule. (Glenbow Archives Photograph ND-3-4661, and Photographs in the Provincial Archives of Alberta) The SRD was able to repaint a maximum of eighteen streetcars a year during this time. Nine streetcars had already been repainted in the old color scheme in 1926 when the new paint scheme was introduced. Only nine additional streetcars could be repainted in the new colors in 1926. (Edmonton Journal, June 2, 1926, p. 13)

Several external modifications were made to the streetcars when they entered the shops for repainting. The roof mounted marker lamps were removed and were replaced by two clear lenses which were installed on the letterboard directly above the middle vestibule windows at each end of the streetcar. The lenses were spaced approximately 15 inches (381 mm) apart. This spacing enabled the two lenses to be distinguished

from a distance, as well as providing space for the car number between them. The lenses were held in place by portions of the old marker lamps which had been dismantled. (Artifacts in the Author's Collection) Holes drilled through the letterboards directly behind the lenses enabled light within the vestibule to reach the lenses. Locally fabricated steel brackets which held several colored glass discs were placed inside the vestibules directly in front of each hole which led to a lens. The discs could be privoted individually in line with the hole, thus changing the color of the light reaching the lens. In this manner, the streetcar could display a colored route designation. A single bulb placed in the vestibule in front of each hole provided light for each lens. (Author's Observations, and Artifacts in Author's Collection) The marker lamps were probably removed because they were prone to damage and tended to leak when it rained or snowed.

A small sheet metal awning was placed over the centre window of each forward-travelling vestibule during this period. (Canadian Railway and Marine World, August 1927, p. 723) The purpose of the awning was to keep direct sunlight out of the motorman's eyes since most of the SRD's passenger streetcars did not possess shades for the front vestibule windows. The awning and the letterboard lenses can be observed in Plate 25. It should be noted that no number is visible on the letterboard between the lenses. This is because the streetcar shown was painted in a later version of the red and ivory paint scheme which omitted the letterboard number.

The SRD mounted rectangular wooden boxes on the dash of each vestibule immediately below the belt rail. These boxes, which were placed adjacent to the doors, were designed to hold painted sheet metal signs which displayed the color or colors of the particular route on which that

streetcar was travelling. The sheet metal signs, which were 12 inches (305 mm) wide by 23 inches (584 mm) long, were supposed to be recognizable from a distance of three blocks. (Letter to the City Commissioners from SRD Acting Superintendent A. Robertson, June 17, 1927, and Artifacts in Author's Collection) At night, the letterboard lenses indicated the color or colors of the route.

A small roller sign was also installed in one of the upper sashes in each vestibule. These roller signs, which resembled the illuminated signs that were installed on the big Preston streetcars, contained three incandescent bulbs for illumination. The signs displayed the location of the terminus of the route. The roller signs were considered to be a supplement to the colored signs and lamps, hence their small size. (Letter to the City Commissioners from SRD Acting Superintendent A. Robertson, June 17, 1927) In addition to these signs and lamps, the SRD placed two metal brackets on each side of each passenger streetcar's body immediately below the belt rail. These brackets, which were spaced several feet (mm) apart, were designed to hold narrow boards on which were affixed advertising messages. (Letter to the City Commissioners from SRD Superintendent W. J. Cunningham, January 19, 1927) The metal signs, roller signs and the brackets can be seen in Plate 25.

During this period, some streetcars were equipped with a trolley rope guide which was designed to prevent the trolley rope from rubbing and snagging on the streetcar's letterboard. The guides were fabricated from steel round stock and were bolted to the letterboard. Small hooks formed at each end prevented the trolley rope from slipping off the guide. (Glenbow Archives Photograph ND-3-4661) The rope guides do not appear to have made a significant difference in operation since only a few streetcars appear to have been fitted with them. (Photograph in

Author's Collection)

Complaints about the type of headlight in use were received by the SRD during 1926. It had been observed by several citizens that the light produced by these incandescent headlights was too dim in areas with little or no street lighting. A concern was expressed that if the light intensity were not improved, a serious accident could occur as the result of the motorman being unable to see a hazard along the track. (Letter to the SRD Superintendent W. J. Cunningham from the City Commissioners, August 3, 1926) In order to avoid the possibility of a fatal accident, the ERR subsequently equipped several passenger and service streetcars with an additional headlight which was mounted on the dash or cab directly above the normal headlight. The new supplemental headlight, which was smaller in diameter than the regular headlight, contained a prismatic reflector which tended to concentrate the light beam to a narrow path in front of the streetcar. In addition, the higher placement of the supplemental headlight meant that the track would be illuminated further ahead than it had been with the standard headlight. (Letter to SRD Superintendent W. J. Cunningham from Canadian Ohio Brass Co., January 9, 1928)

The speed of loading and unloading the big Preston streetcars remained slow in spite of the increase in space of the front vestibules. Superintendent Cunningham, wishing to overcome this problem, planned to install a treadle operated door in the rear vestibule of a big Preston streetcar as an experiment in late 1926. (Letter to Railway & Power Engineering Corp. from SRD Superintendent W. J. Cunningham, December 22, 1926) The treadle operated rear door was intended to allow passengers to leave by the rear vestibule, thus reducing crowding in the front vestibule.

The treadle assembly, which was manufactured by the National Pneumatic Company and purchased from the Railway and Power Engineering Corporation of Toronto, consisted of a steel plate (the treadle) which was 20 inches by 25 inches (508 mm X 636 mm) in size. The treadle was hinged along one edge and rested on top of spring loaded electrical switch, the contacts of which were normally open. A small pipe was installed in the front vestibule which was connected to the air pipe leading from the brake valve to the brake cylinder. A small rotary valve, which was similar in operation to the air brake valve, was attached to the end of the pipe. This valve, referred to as the "conductors control", was connected to another pipe which led to a magnet valve which was located in a box placed above the right-hand doorway in the rear vestibule. The magnet valve, in turn, was connected to an air cylinder which was located next to the magnet valve. (Letter to SRD Superintendent W. J. Cunningham from Railway & Power Engineering Corp., April 11, 1927, p. 3) The piston in the air cylinder was connected to a lever which could open and close a folding door which was installed beneath the cylinder and the magnet valve.

The operation of the treadle exit was simple and safe. When the air brakes were applied, compressed air reached the pipe leading to the conductors control. When the motorman moved the handle on the conductors control to the right, the compressed air was allowed to reach the magnet valve. If a passenger stepped on the treadle at this time, the switch beneath the treadle would close a circuit leading to the magnet valve. The electromagnet on the valve, which acted as a solenoid, opened the valve, enabling air to reach the cylinder. The air pushed the piston in the cylinder and, in turn, opened the door through the levers, allowing the passenger to leave. When the passenger stepped off the treadle,

the circuit to the magnet valve was opened and the air supply to the cylinder was cut off. A spring inside the cylinder forced the piston back to its original position. A small hole in the cylinder prevented the air from escaping too quickly, thus preventing the alighting passenger from being injured by the doors. In addition, the edges of the doors contained hollow rubber strips which were intended to prevent a passenger's arm or hand from being crushed should the doors close before they were clear. Safety features were also incorporated into the design of the treadle unit. While the doors were open, air travelled along a pipe which led from the cylinder to a double check valve which prevented both the air in the brake cylinder and the air in the door mechanism from being released. This safety feature eliminated the possibility of a motorman moving the streetcar before the rear door was closed. In addition, indicator lights located in the front vestibule informed the motorman whether the rear door was open or closed. (Letter to SRD Superintendent W. J. Cunningham from Railway & Power Engineering Corp., April 11, 1927, pp. 3-4)

The installation of the treadle in a big Preston streetcar was not a simple operation. The treadle and the switch had to extend below the floor level. No obstructions, therefore, could be tolerated beneath the location of the treadle. One of the steel vestibule knees happened to lie directly beneath the proposed location of the treadle. SRD crews had to relocate the knee several inches (mm) towards the centre of the vestibule before the treadle could be installed. Once this was done, a portion of the vestibule floor was removed. A two tread metal step assembly was fabricated which incorporated the treadle as the upper tread. This assembly was bolted to the floor and to the knee. A single-width folding door was installed between the treads of the assembly.

The door and treadle were placed next to the rear bulkhead for extra support. (SRD Drawing of Rear Exit for Treadle Steps, December 1926)

Only streetcar Number 74 was fitted with a treadle assembly. (Cunningham, 1927, p. 2) The operation of the treadle mechanism was observed for several months and was deemed successful. Although the treadle functioned satisfactorily, most passengers were reluctant to use it, preferring to exit by the front door. (Cunningham, 1929, p. 2) No further streetcars were fitted with the rear treadle exit and the unit on Number 74 was eventually removed. The difficulty and expense of installing the treadle assembly combined with the public's reluctance to use that exit probably convinced the SRD to abandon further plans for installing the treadle exit on the big Preston streetcars.

Several streetcars underwent extensive rebuilding during this period. The vestibules on some of the older wooden frame units had begun to sag badly. In addition, the side sills on some of these units were checked or were otherwise weak. These streetcars had to undergo extensive rebuilding or they would have been unsafe to operate. (SRDAR, 1925, p. 2; 1926, p. 1 & p. 4) In an attempt to prevent further problems with the weakened wooden sills, a number of streetcars had steel channel beams installed above the side sills while they were being overhauled. The beams, which were bolted to the sills and their metal reinforcing strips, extended from one end of the frame to the other and eliminated the need for trusses on these streetcars. (Author's Inspections of Streetcar Number 13 and the Frame of Streetcar Number 24) In order to install the channel beams, the exterior sheathing had to be removed. In addition, several window posts and some of the cross-bracing had to be relocated. Photographic evidence indicates that nine streetcars were repaired in this fashion, Numbers: 8, 9, 11, 13, 15, 17, 19, 24 and 27. (Photographs

in Author's Collection)

Towards the end of this period, Superintendent Cunningham began to express concern to the City Commissioners about the condition of the trucks, motors, gears and axles of the streetcars in service. In the 1926 Street Railway Department Annual Report, Cunningham stated, "The car trucks need continual attention but are kept in repair by welding" (p. 2). Cunningham investigated the possibility of replacing some of the trucks in bad condition with new trucks. In spite of several offers from truck manufacturers, Cunningham believed that the expense was not justified since most of the streetcars were becoming obsolete and would likely be retired in a few years. (Letter to the Canadian Car and Foundry Co. from SRD Superintendent W. J. Cunningham, February 11, 1927, March 7, 1930 and SRDAR, 1928, p. 2)

The SRD did, however, attempt to make some improvements to the motive power of the streetcars in service during this period. In 1925, several sets of spur gears were replaced by helical gears of the same size and ratio as the spur gears. (Letter to SRD Superintendent W. J. Cunningham from Canadian Westinghouse Co., February 20, 1925, and Letter from Canadian General Electric Co., April 15, 1925)

A helical gear is similar in appearance to a spur gear except that the teeth of a helical gear are cut so that they conform to the layout of a helix. The teeth, therefore, slant diagonally across the face of the gear. (Repp & McCarthy, 1979, p. 354) The main advantage of helical gears over spur gears are: the teeth of helical gears slide across each other rather than striking each other as they do in spur gears; helical gears produce less noise in operation; the helical layout of the teeth enable several teeth to be engaged at a time, thus providing greater gear strength. The major disadvantage of helical gears is that the

increased contact area of the teeth produce more friction, so heat dissipation and lubrication can be problems. (Repp & McCarthy, p. 354) In addition, helical gears tend to be more expensive than spur gears because of their construction.

The helical gears supplied to the SRD were classified as "Grade M" solid gears. (Letter to SRD Superintendent W. J. Cunningham from General Electric Co., May 14, 1930) The grade "M" referred to the type of steel used in the gear which was a hardened and tempered medium carbon steel. The gears were fabricated from a single block of steel. Solid gears, unlike split gears, were better suited for heat dissipation. (General Electric Co. Catalog No. 20, 1920-1921, p. 697)

The operation of the helical gears appears to have been successful since the SRD continued to replace worn spur gears with helical gears throughout the 1920's. (SRDAR, 1928, p. 3)

It was mentioned in an earlier section that streetcar Number 3 had been retired at the end of 1927. By 1929, the ridership on the street railway had increased by such an extent that extra streetcars were required quickly. Superintendent Cunningham believed that it was possible to rebuild Number 3 and to place it back in service. It is, therefore, apparent that Number 3 was not scrapped after its retirement. During the rebuilding of that streetcar, it was changed from double end to single end operation. (Letter to Commissioner D. Mitchell from SRD Superintendent W. J. Cunningham, April 8, 1929) It seems likely that the vestibule selected to be at the rear of the unit was lengthened in order that it could be used as a smoking compartment. It should be recalled that an SRD listing of passenger equipment from the early 1920's listed streetcars 1, 3, 4, 5 and 6 as all having the same overall length as the length stated in the builder's specifications of 1908. (SRD Table of Weights

and Levers, circa 1920) The rear vestibule was lengthened approximately 16 inches (406 mm). (Author's Measurement of Streetcar Number 1, and Photographs by R. J. Walker) It should also be noted that streetcar Number 1 was also rebuilt during 1929. (Edmonton Journal, June 8, 1929, p. 20) It is probable that Numbers 1 and 3 both received the same rebuilding modifications since both streetcars appear to be, on the exteriors, identical in subsequent photographs. Numbers 4, 5 and 6 also received lengthened rear vestibules before the 1930's. (Photographs in the Author's Collection, and Photographs by R. J. Walker)

A new type of motor and controller were installed on one streetcar in 1929. When the SRD had decided to resurrect Number 3, they had to obtain new motors and control equipment since the apparatus originally in place on that streetcar had been removed and used elsewhere. (Letter to Commissioners D. Mitchell from SRD Superintendent W. J. Cunningham, April 8, 1929) By this time, the GE-80A motor and the K-6 controller were considered obsolete. (Letter to SRD Superintendent W. J. Cunningham from Canadian General Electric Co., February 3, 1927) In order to observe directly any improvements made in the design and efficiency of motors and control equipment, the SRD obtained quotes on modern equipment. The bid of the Canadian General Electric Company was the lowest so the equipment was obtained from that firm. (Letter to Commissioner D. Mitchell from SRD Superintendent W. J. Cunningham, April 8, 1929)

The equipment consisted of four GE-247A-1 motors and a single K-35 controller. (Canadian General Electric Co. Specifications of Equipment, October 25, 1929) The GE-247A motor was much smaller in size than the GE-80A, although they had the same power rating. Smaller gears had to be used with the 247A motor because of its smaller size.

The normal gear ratio for a GE-247A motor was 58 to 15, the larger number of teeth being found on the axle gear. (General Electric Co. Drawing of GE-247A Motor, October 1926) The K-35 controller, which was identical in external appearance to a K-6 controller, possessed a greater number of fingers than the K-6 and possessed a different power shaft arrangement which enabled it to have fewer notches. The greater number of fingers, in addition to a more efficient internal design, meant that the K-35 controller could provide faster and smoother acceleration with fewer notches than the K-6 controller. The K-35 controller, as well, had provision for the installation of an automatic line breaker and other safety equipment. (General Electric Co. Schematic Drawing and Specifications of K-35-HH Controller, May 1925, and Thompson, 1940, pp. 158-159)

It is probable that the SRD did not desire to install this equipment on Number 3, which was one of the SRD's oldest streetcars. The new equipment was installed on big Preston streetcar Number 56. (Letter to SRD from Canadian General Electric Co., June 3, 1930) It is most probable that the GE-80A motors and the K-6 controller that had been on Number 56 were removed and were installed on streetcar Number 3.

Passenger Equipment, 1930

As early as 1928, Superintendent Cunningham predicted the need for additional passenger rolling stock. "With the increase in traffic it will be necessary to consider the question of obtaining additional rolling stock next year" (SRDAR, 1928, p. 2). It should be recalled from the previous section that the SRD resurrected Number 3 during 1929 because of an acute shortage of passenger equipment. The ridership on the street

railway continued to increase and in March 1930, Superintendent Cunningham asked the City Council to authorize the purchase of six new streetcars which would alleviate the rolling stock shortage. (Edmonton Journal, March 10, 1930, p. 9) The City Council's decision on this matter was not forthcoming since the Council wished to receive estimates of the total cost. (Canadian Railway and Marine World, March 1930, p. 165) The SRD advertised for bids for the new streetcars.

A particularly interesting and ironic offer was received by Cunningham in April. The equipment broker D. M. Campbell offered to sell the SRD streetcars Numbers 80 and 81 which had been sold to the Oshawa Street Railway in 1917. (Letter to SRD Superintendent W. J. Cunningham from D. M. Campbell, April 14, 1930) Campbell was able to offer the units for sale because the Oshawa Street Railway had recently been taken over by the Canadian National Railways and that Company did not wish to operate that type of streetcar on its lines. (Letter to SRD Superintendent W. J. Cunningham from D. M. Campbell, April 29, 1930) After some consideration, Cunningham decided against the purchase of any used rolling stock. (Letter to D. M. Campbell from SRD Superintendent W. J. Cunningham, July 28, 1930) The May 7 City Council meeting authorized the purchase of new streetcars by the SRD based upon the estimates supplied to them by the City Commissioners. (Canadian Railway and Marine World, March 1930, p. 165)

On May 9, Cunningham submitted a summary of the bids received to the City Commissioners for their final selection and approval. Bids had been received from: the Ottawa Car Manufacturing Company (formerly the Ottawa Car Company), the National Steel Car Corporation of Montreal, and the Canadian Car and Foundry Company. Bids for the motor and air brake equipment were received from both the Canadian

General Electric and Canadian Westinghouse Companies. The lowest bid for the streetcars was received from the Ottawa Car Manufacturing Company. The cost per unit, however, was greater than the capital estimates approved by Council. Cunningham, therefore, recommended that only five streetcars be ordered. Cunningham also recommended that the motor and the air brake equipment be purchased from the Canadian General Electric Company, which was the lowest bidder. (Letter to the City Commissioners from SRD Superintendent W. J. Cunningham, May 9, 1930)

The City Commissioners concurred with Cunningham's recommendations and an agreement was finalized with the Ottawa Car Manufacturing Company on June 30, 1930. The contract stipulated, however, that the air compressors were to be supplied by the Canadian Westinghouse Company. (Ottawa Car Manufacturing Co. Contract for Streetcars, June 30, 1930)

The general specifications for these streetcars, provided by the SRD when the bids were solicited, stated that each streetcar was to have double-width folding doors in the front vestibule and a treadle operated exit door at the centre of the body on the right-hand side. In addition, the electrical equipment was to include a pneumatically operated line breaker, helical gears, and air operated safety control which would stop the streetcar should the motorman lose control for any reason. (SRD General Specifications for Six Single-End Streetcars, March 1930)

The specifications prepared by the Ottawa Car Manufacturing Company embodied all of the general specifications as well as some improvements. With the exception of the roofs and the interiors, metal was used for the entire construction of these streetcars. Open hearth steel "Z" beams were used for the intermediate sills while angle shapes and

channels were used for the side and end sills, as well as for the window posts and the carlines. All steel members were riveted together. Separate vestibules were abandoned in this design. The front end of the frame was shaped so that it resembled the long vestibules on some of the earlier ERR double-end streetcars. The rear portion of the frame was shaped so that each side angled in towards the centre of the frame. This design reduced body overhang when the streetcar travelled around curves. (Ottawa Car Manufacturing Co. Specifications of Streetcars, May 1930, pp. 3-5) Body overhang was an extreme hazard to motor vehicles that happened to be travelling next to a streetcar as it made a turn.

The older style of bunter was superseded by a 7 inch (178 mm) wide rolled steel section which was called an "anticlimber". An anticlimber resembled an ordinary bunter except that an anticlimber bunter possessed several horizontal ridges of steel along its face. The purpose of the ridges were to prevent serious damage from occurring to the streetcar's vestibules should it be rammed by another streetcar. In the past if such an accident occurred, one of the colliding streetcars slid up on the bunter of the other streetcar. The result was considerable damage to the vestibule that was struck by the streetcar. This action not only destroyed the vestibule but also endangered the safety and the lives of any people in the vestibule. If both streetcars possessed anticlimbers, however, neither streetcar could slide above the other. Vestibule damage as well as danger to individuals would be minimized. Draw bar anchors were also placed at both ends of the frame. A portable draw bar was hung underneath the left-hand side of the body. It could be attached to one of the anchors if needed. (Ottawa Car Manufacturing Co. Specifications, p. 8) The absence of a fixed draw bar eliminated

a possible hazard to individuals who fell in front of the streetcar. The builder also furnished a steel version of the HB lifeguard on the front of each streetcar. (Ottawa Car Manufacturing Co. Specifications, p. 10)

The window sashes were fabricated of brass. The lower part of the sash was designed to be raised a short distance with the exception of the sashes near the ends of the streetcar. Sash pockets were not required for the sashes that raised. The windows at the rear of the streetcar were stationary except for the centre window at the rear which could be dropped into a special sash pocket. The front centre window as well as the front right-hand window were also stationary but the window to the left of the motorman could also be dropped into a sash pocket. The front centre window was equipped with a single blade hand-operated windshield wiper. (Ottawa Car Manufacturing Co. Specifications, p. 8) It is important to note that these streetcars were the first vehicles on the ERR to possess such equipment. A set of small wire netting window guards were supplied with each streetcar in addition to a set of storm sashes for winter use. (Ottawa Car Manufacturing Co. Specifications, pp. 5-7)

The roofs of these streetcars were composed of white ash supports which were sheathed with poplar or basswood strips. Four ventilation ducts which were manufactured by the Nichols-Lintern Supply Company were installed along each side of the roof. The exterior surface of the roof was covered with Number 10 canvas duck and a waterproof coating. A running board as well as a trolley board, trolley base, trolley pole and a trolley rope guide were installed on the roof. (Ottawa Car Manufacturing Co. Specifications, pp. 5-7)

The interior flooring consisted of 7/8 inch (22.5 mm) thick white pine tongue and groove boards which were laid transversely. Narrow

maple strips were then nailed longitudinally along the aisle areas. On either side of the strips the builder nailed 5/8 inch (16 mm) thick maple boards. These boards were aligned longitudinally. When complete, the flooring was painted with a light stone grey floor paint. The use of maple (a hard wood) for the floor meant that the floor boards would not wear as quickly as the floors in the older streetcars which were laid with pine boards (a soft wood). The flooring extended evenly from one end of the interior to the other. (See Plate 32)

The interiors were finished in clear birch between the belt rail and the ceiling. The birch was stained to resemble cherry. The wainscoating and the ceiling were composed of Agasote which was a manufactured material composed of wood fibres. Agasote was similar to masonite. The Agasote was held in place by stained birch moldings which were attached to the posts by screws. Agasote was used because of its recognized qualities as a heat insulator, a necessary feature for Edmonton. (Ottawa Car Manufacturing Co. Specifications, p. 8) Heating was provided by a Peter Smith heater in addition to ten supplemental underseat electric heaters. The interior lighting consisted of five 60 W incandescent bulbs, arranged in series, which were each enclosed in a domed glass fixture. In addition, two smaller bulbs were located near the front steps. It should be noted that flexible braided wire was used on these streetcars in place of the older solid copper wire. The wires, furthermore, were enclosed in galvanized steel conduits. The wiring was done in accordance with Federal electrical codes of that time. (Ottawa Car Manufacturing Co. Specifications, pp. 10-12)

The interior did not contain substantial bulkheads since they were not required. The movement of passengers through the interior was not impeded. The small bulkheads allowed for better heat circulation as

well. The seating capacity of these streetcars was 51. A total of 17 leather upholstered cross seats were arranged along the sides of the interior in addition to two longitudinal seats placed near the front. The cross seats could seat two passengers apiece while the longitudinal seats could each accommodate three passengers. A leather covered semi-circular seat was also placed in the rear vestibule. Several stanchions were placed in the interiors. One set of stanchions guided passengers past the fare box when they entered by the right-hand front door. Stanchions were also placed around the motorman's position. These stanchions supported a canvas curtain as well as a small swing seat that could be used by the motorman. Horizontal stanchions were also placed above the semi-circular seat and above the longitudinal seats. The stanchions consisted of hard-drawn aluminum tubing. Stanchions that extended from the floor to the ceiling were reinforced with ash dowelling. (Ottawa Car Manufacturing Co. Specifications, p. 9, and Drawing T-84) It should be realized that these streetcars were the first SRD vehicles that used aluminum in part of their construction.

The interior signaling system consisted of a buzzer that operated on trolley voltage that was reduced by a resistor grid. Twenty-five push button switches, connected in parallel, enabled the passengers to operate the buzzer. The switches were mounted on the side posts along the interior as well as on the bulkheads. (See Plate 32)

Two fixed steel steps were placed in a well in front of the centre door, while a single step was placed in a well in front of the front doors. The centre doors covered the centre steps in order to prevent individuals from attempting to board there. The front doors were connected to a single-tread folding step. The treads were fabricated of steel bar stock so that it resembled a "honeycomb" pattern. The holes through

the treads prevented the accumulation of snow and ice. The doors, which folded, were fabricated of cherry and were arranged to open and close by a system of air cylinders and levers. The centre doors were operated by a treadle mechanism which was similar in design to the treadle mechanism described in a previous section. (Ottawa Car Manufacturing Co. Specifications, pp. 7-9) Each streetcar was equipped with a switch iron holder, a switch iron and a guide hole through the floor which enabled the motorman to throw a switch without having to leave the streetcar. (Ottawa Car Manufacturing Co. Specifications, p. 11) This was a feature that was not present on earlier SRD rolling stock. Unless the motorman could stop his streetcar precisely above the switch tongue, he would have to leave the streetcar in order to be able to throw the switch. (See also Chapter III)

The exteriors of these streetcars were finished with 3/32 inch (2.5 mm) thick sheet steel panels which were riveted to the frame and the posts. The belt rails were formed of the same sheet steel and were arc welded to the window posts in order to prevent water from entering the interior. The sheathing on the ends was of the same material but the panels were secured to the posts by screws. In the event of a mishap, it would be easier for the repair crews to remove these panels since they were not riveted. In most collisions, the ends of the streetcar were most likely to sustain damage. (Ottawa Car Manufacturing Co. Specifications, pp. 5-6)

Illuminated roller signs were installed over the centre window of each vestibule, in addition to a non-illuminated roller sign which was placed above the first right-hand body window. The front roller sign was a double unit which displayed both route colors and termini locations. The rear roller sign displayed route colors only while the side roller sign

displayed termini locations. It should be noted that the side roller sign received some illumination from the interior of the streetcar. (Ottawa Car Manufacturing Co. Specifications, pp. 8-9) A single Ohio Brass Company type WCF headlight was mounted on the front dash of each streetcar. This type of headlight contained a prismatic reflector. In addition, the sides of the housing consisted of heat resistant glass for dash illumination. A Nichols-Lintern traffic light was placed on the rear dash. (Ottawa Car Manufacturing Co. Specifications, p. 13, and Ohio Brass Co. Catalog 23, 1940, p. 170) This device consisted of a metal housing which contained two incandescent bulbs and two colored lenses, one red and the other green. When the brakes were applied, a switch would be closed that turned on the lamp behind the red lens. When the controller was on, the bulb behind the green lens was turned on while the lamp behind the red lens was extinguished. In this manner, the traffic light informed a motorist whether the streetcar was stopping or was moving ahead. It is probable that this device prevented many motorists from ramming a slowing or a stopped streetcar so equipped. The rear dash also held a Number 10 Earll trolley catcher which was similar to the type of catchers used by the other SRD streetcars. (Ottawa Car Manufacturing Co. Specifications, p. 13)

The streetcars were painted in the red and ivory paint scheme described previously. There were two modifications, however. The letterboards were painted red instead of ivory. The number at the ends of the streetcar could not be placed on the letterboards because of the roller signs. The numbers, in gold, were centred on the dashes below the centre windows at each end. (See Plate 31) The streetcars were numbered 80 through 84.

Each streetcar was mounted on two Canadian Car and Foundry

F-920 trucks. These trucks were similar in basic appearance to the Brill 27-GE-1 truck but were substantially different. The wheel base of the F-920 truck was 5 feet 4 inches (1 626 mm). This longer wheel base enabled the trucks to be arranged to accommodate two motors that were hung between the axles (inside hung). Streetcars equipped with such trucks could travel faster than streetcars with outside hung motors. The old type of sleeve bearing journal box was replaced by journal boxes which contained spherical roller bearings. (Canadian Car & Foundry Co. Drawings and Specifications of Type F-920 Truck) Roller bearings were selected because Superintendent Cunningham had obtained favorable information on them from the Canadian Car and Foundry Company and the Canadian SKF Company (a bearing manufacturer). The information received indicated that roller bearings reduced starting friction which, in turn, reduced the current consumption of the motors. In addition, infrequent maintenance was required with the roller bearings, unlike the constant maintenance required by the older type of bearings and their packing. It should be noted that the use of roller bearings in street railway trucks was new and, consequently, was not widespread. (Letter to SRD Superintendent W. J. Cunningham from Canadian Car & Foundry Co., February 19, 1930, and Letter from Canadian SKF Company, March 26, 1930) The trucks were fitted with rolled steel wheels which were 26 inches (660 mm) in diameter. This wheel diameter was selected for two reasons. Firstly, a 26 inch (660 mm) diameter wheel was the type recommended for use with the CGE-247L motor which was to be installed on each axle. Secondly, the smaller diameter of these wheels meant that the streetcar's steps would be closer to the ground. This would make it easier for passengers to alight and to board the streetcar. (General Electric Co. Bulletin No. GEA-418, June 1926, and Ottawa Car Manu-

facturing Co. Specifications of Streetcars, May 1930, p. 7 & p. 9)

Four CGE-247L-1 motors were installed on each streetcar. (Ottawa Car Manufacturing Co. Specifications, p. 13) These motors differed from the GE-247A motor which was described in a previous section. The CGE-247L motor was manufactured in Canada and contained castings so that it could be inside hung on a truck. In addition, the form L motor contained the General Electric Company's patented constant oil level bearing in which the oil level in the bearing housing was kept at the optimum level through a system of wicks and reservoirs. (General Electric Co. Bulletin GEA-418, June 1926) Solid type M helical gears with the ratio of 58 to 15 were also installed with each motor. (Letter to SRD Superintendent W. J. Cunningham from the Canadian General Electric Co., May 14, 1930)

Each streetcar was also equipped with one K-35-HH controller which was located in the front vestibule. (Ottawa Car Manufacturing Co. Drawing of Piping Layout, 1930) The K-35-HH controller was similar in appearance to a regular K-35 controller. The HH designation signified that the controller was designed to hold a power handle which also controlled a small air valve. This air valve, called a pilot valve, controlled air flow to a pneumatic line breaker which was located beneath the controller. (General Electric Co. Drawing of Connections for K-35-HH Controllers, May 1925) The handle, which had the designation "LB-4", was supplied by Safety Car Devices Company of Wilmerding, Pennsylvania which marketed Westinghouse products. The handle was partially enclosed in a housing which was bolted to the top of the controller. The centre of the handle contained a pivot so the handle could be moved vertically. The end of the handle beyond the pivot, inside the housing, was connected to a spring-loaded valve which was normally open. The other end of the

handle held a small wooden knob which the motorman gripped. In order for the controller to function, the motorman not only had to rotate the handle in a clockwise direction, but had to push down on the handle as well or the pneumatic line breaker would not close the circuit to the motors. By holding the handle down, the pilot valve permitted compressed air to reach the pneumatic line breaker. Approximately 6 pounds (27 kg) of pressure were required to keep the handle down. A foot valve, mounted on the floor, enabled the motorman to release the handle. If the handle was released at any time the controller was on and the foot valve was not depressed, the pneumatic breaker would open, cutting power to the motors. (Safety Car Devices Co. Specifications of Controller Handle with Pilot Valve, March 1928) In addition to this action, the brakes would be applied automatically.

The air brake equipment supplied with these streetcars was more complex than the air brakes of earlier SRD rolling stock. Each unit was equipped with one Westinghouse DH-25 compressor. (Ottawa Car Manufacturing Co. Contract for Streetcars, June 30, 1930, p. 1) The DH-25 compressor was selected because it had a larger motor than other trade names and models of compressors. In addition, the DH-25 compressor could displace 25 cubic feet (0.71 m^3) of air in a minute, a greater displacement than the older D-1-EG compressor. (Westinghouse Co. Specifications of DH-25 Motor Driven Air Compressor, October 1928) The basic operation of the brakes was similar to the brakes found on earlier units of rolling stock. The brakes applied to these streetcars were designed to operate faster. In addition, they were interconnected with the controller handle through an emergency valve.

A disadvantage of the older straight air brake was that it took several seconds for the brakes to be applied once the brake handle was

moved to the "service" position. This delay was caused by the distance the air had to travel between the brake valve and the brake cylinder. The new system partially solved the problem by placing an air relay valve in the pipe between the brake valve and the brake cylinder. A relay valve was designed so that it admitted reservoir air to the line when it was pressurized. In this manner, the air pressure in the pipe did not drop appreciably with the distance travelled by the air. If an emergency arose and the streetcar had to stop quickly, the short lag in brake operation could prove to be fatal. With this in mind, an "emergency straight air brake system" was designed. This system incorporated a spring valve which was known as an emergency valve. An emergency valve was installed beneath the streetcar on a pipe which led from the air reservoir. Another pipe connected the valve to the brake cylinder. An additional pipe was connected between the spring diaphragm of the emergency valve and the controller pilot valve, foot valve and the brake valve. If for any reason the controller handle was released while the controller was on, or the brake handle was moved to the "emergency" position, air pressure would be diverted to the emergency valve. This air pressure would compress the diaphragm in the emergency valve which would permit reservoir pressure to travel the short distance between the reservoir and the brake cylinder. With this action, the brakes would be applied without much delay. (Harding & Ewing, 1926, p. 385)

A Westinghouse MD-28-F combination brake valve, selector valve and sanding valve was installed on streetcars 80 to 84. The brake valve, which contained an "emergency" position, also controlled the opening and the closing of the doors. A smaller valve, which was attached to the brake valve, determined whether the front doors, centre door, or both sets of doors were to be opened. When the brake handle was moved

to the position beyond "service", the doors chosen by the selector would open or, in the case of the centre door, could be opened. When the motorman moved the handle to the left, the doors closed. The front doors opened and closed in this fashion through two air cylinders, one for opening, the other for closing. The centre door was operated by a treadle so the brake and selector valve controlled the air supply to the magnet valve. In an emergency brake application, the air supply pipes to the door cylinders were opened so that the air pressure in each cylinder would be balanced. The doors could then be pushed open, if required.

The brake handle was also hinged so that it could pivot downwards in any position on the brake valve. When the brake handle was pushed down, it pushed on a semi-circular casting which was also hinged. This casting was referred to as a "sanding bail". The purpose of the sanding bail was to push open a small spring-loaded valve which enabled compressed air to reach the sanders. In this manner, the motorman could apply sand to the rails without releasing his hold on the brake handle. (Safety Car Devices Co. Specifications of M-28 Type Brake Valves, April 1928) Figure 38 (after Westinghouse Drawing of Type M-28-D Brake Valve with Selector Valve and Sanding Feature) depicts, in plan view, the brake valve described above. The handle positions should be noted.

Two air operated sanders were supplied with each streetcar. These sanders were operated from the brake valve described above. These streetcars were also equipped with a staffless hand brake which was located to the left of the motorman. (Ottawa Car Manufacturing Co. Specifications of Streetcars, May 1930, pp. 9-10)

Air operated warning devices were given prominence on streetcars 80 through 84. In addition to a foot gong located beneath the motorman's

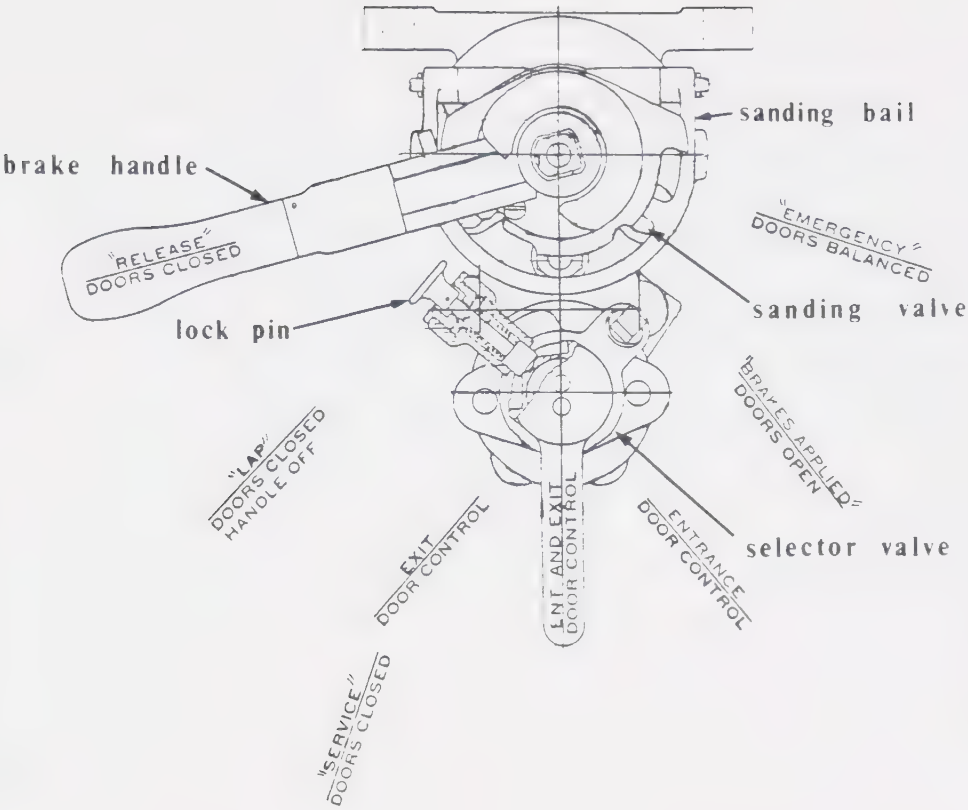


FIGURE 38. TYPE MD – 28 VALVE

position, a whistle was mounted on the letterboard to the right of the front roller sign. (See Plate 31) An additional whistle was placed at the rear of the streetcar beneath the floor. This whistle was operated by the motorman and was used to warn pedestrians and motorists when the streetcar travelled in reverse. (Ottawa Car Manufacturing Co. Specifications, p. 13, and Drawing of Piping Layout)

When the streetcars were complete and in operating condition, they were sent to Edmonton. (Ottawa Car Manufacturing Co. Contract for Streetcars, June 30, 1930) The total weight of each streetcar in this series, including the trucks, was approximately 40,950 pounds (18 575 kg). (Ottawa Car Manufacturing Co. Catalog circa 1931, reprinted 1968,

p. 5A) Although streetcars 80 through 84 were composed primarily of steel, each streetcar was more than 5,000 pounds (2 268 kg) lighter than each of the big Preston streetcars. The lighter weight of streetcars 80 through 84 meant that they would cause less damage to the roadbed than the heavier big Preston streetcars. It is significant to note that streetcars 80 through 84 were the last streetcars to be purchased by the SRD. Plate 31 (Author's Collection) shows the external appearance of streetcar Number 84 sometime during the 1930's. The folding steps, roller bearing trucks and the letterboard whistle should all be noted. The Crouse-Hinds type Z headlight, as well as the route colors on the mirror were added after the streetcar had been in service in Edmonton. Plate 32 (Author's Collection) shows the interior of Number 84. The following should be noted: dome light, leather upholstered seats, small rear bulkhead, centre exit, Agasote ceiling and stanchions.

Freight and Service Equipment, 1938

It was noted in Chapter III that by the mid 1930's, serious corrugations had developed along some sections of the SRD's permanent track. A device was needed to smooth the corrugations before they damaged both the rails and the rolling stock.

In 1937, the SRD received from the Toronto Transportation Commission plans for rail grinding apparatus which that company had designed for its street railway. The grinding apparatus consisted of several abrasive blocks which were held in a steel yoke. The yoke was designed so that when it was installed beneath a streetcar, a set of abrasive blocks would be located above each rail. A lever and spring arrangement enabled the blocks to be pressed, with varying degrees of firmness, against the heads of the rails. When the blocks were in this position, they would

Plate 32. (Author's Collection) Interior of Streetcar Number 84

Plate 33. (Provincial Archives of Alberta) Library Car and Bus Number 4

abrade the rails as the streetcar travelled. The plans also called for heavy weights to be placed on the streetcar equipped with the grinders. (Toronto Transportation Commission Drawings of Rail Grinding Apparatus, February 1937) The purpose of the weight was to prevent the abrasive blocks lifting the streetcar rather than bearing down on the rails. A streetcar was needed that could be fitted with both the grinding apparatus and the heavy weights.

The weed killer car, former passenger streetcar Number 7, was ideally suited for this purpose. It possessed no body, it held a large storage tank which could be filled with water, and was not required for most freight or service assignments. In order to be effective, however, the car had to be self-powered. The SRD crews, therefore, reinstalled the two GE-80A-1 motors on the car. Two K-6 controllers were also mounted at each end of the frame. A small wooden platform, supported by four angled wooden posts, was located several feet (mm) above the tank. The platform supported a single trolley base and pole which enabled the grinder car to collect current from the trolley wire. (Photographs in Author's Collection)

In addition to installing the grinding and the electrical equipment, the SRD removed the weed killing apparatus. The brake wheels were replaced by brake handles so that the streetcar could be slowed and stopped easily. Metal stanchions were also placed along each side of the car. In addition, small windshields were placed at both ends of the grinder car. The windshields each supported one Crouse-Hinds type Z incandescent headlight. (Photographs in Author's Collection) The conversion of the weed killer to a rail grinder took place during 1938. The unit was placed in service by the end of October of that year. (Edmonton Bulletin, November 8, 1938, p. 9)

It should be noted that the depression of the 1930's severely limited the extent of maintenance and modifications carried out on the streetcars. The use of helical gears was discontinued during this period because of their high cost. (SRDAR, 1936, p. 1) It had also been the intention of the SRD in 1931 to install air cooling tanks on each streetcar, thereby reducing the risk of frozen air equipment during cold weather. (Letter to ERR Superintendent W. J. Cunningham from the Standard Iron Works, September 8, 1931) An air cooling tank accepted the compressed air directly from the air compressor. The air from the compressor, being heated, would expand and would drop most of its moisture as condensate in the tank before passing onto the main reservoir and the other air apparatus. The SRD, unfortunately, did not have sufficient funds to undertake this project. (SRDAR, 1931, p. 2) The depressed economic conditions also forced the SRD to obtain its steel castings, such as brake shoes, in Edmonton in order to assist local businesses. In the past, most foundry work had been done by the Manitoba Steel Foundries of Winnipeg. (Letter to Manitoba Steel Foundries from SRD Superintendent W. J. Cunningham, May 8, 1930) The depression also prevented the street railway from installing any Nichols-Lintern traffic lights on any more streetcars. It was noted, in a previous section, that streetcars 80 through 84 were each equipped with the device because it was believed that it would reduce the number of rear end collisions of motor vehicles with streetcars.

It was mentioned in a previous section that streetcars 80 through 84 had been equipped with anticlimbers. In order for the anticlimbers to be effective, each passenger streetcar operated by the SRD had to have anticlimbers as well. The SRD decided to secure a small section

of anticlimber onto the bunters of each passenger streetcar. These anticlimbers were fabricated of steel and they contained four ridges each. Two bolts were used to secure each section to the centre of each bunter. (Photographs in Author's Collection) Plate 25 (Author's Collection) shows the anticlimber as it was installed on the front bunter of streetcar Number 29. By the late 1930's every passenger streetcar in Edmonton that was fit for service had anticlimbers in place. (Photographs in Author's Collection)

For several years, the Westinghouse 101-B-2 motors in use by the SRD had been found to be prone to burn outs and shorting. The problem had arisen because the design of the motor armature enabled carbon dust from the brushes to accumulate between the ends of the commutator bars and the interiors of the armature windings. When a sufficient quantity of the carbon dust had accumulated, a current path between the commutator bars and the armature windings was formed. If the insulating varnish was flawed or weak on any portion of the windings, a short circuit would be formed which usually caused that winding to burn out. In an attempt to prevent this condition from occurring, the SRD fabricated a two-piece oak collar which was placed between the ends of the commutator bars and the ends of the armature windings. The collar, which was held in place with wire and insulating tape, prevented the carbon dust from accumulating between the windings and the commutator bars. In this manner, the design flaw of the Westinghouse 101-B-2 motor was overcome. (Letter to Canadian Westinghouse Co. from SRD Superintendent T. Ferrier, August 13, 1945)

The collar was so successful at preventing the armatures of Westinghouse 101-B-2 motors from burning out that other Canadian street railways adopted the use of the Edmonton street railway collar. The collar

eventually reached the attention of Canadian Westinghouse personnel who endeavoured to correct the design flaw by changing the size and the shape of the armature windings for the 101-B-2 motor. (Letter and Enclosure to SRD Superintendent T. Ferrier from Canadian Westinghouse Co. District Engineer W. S. Fraser, August 4, 1945)

A previous section also mentioned that streetcars 80 through 84 had been equipped with hand operated windshield wipers. Before 1935, the SRD endeavoured to equip other streetcars in their fleet with a similar type of hand operated wiper. (Letter to SRD General Foreman A. R. Brass from J. G. Brill Co., October 18, 1933) The SRD discovered that hand operated wipers were unsatisfactory since the motormen usually had one hand on the controller and the other hand on the brake valve when the streetcar was in motion. (Letter to E. A. Arnott, Transportation Manager of B. C. Electric Railway Co. from SRD Superintendent T. Ferrier, December 5, 1941)

An air operated wiper manufactured by the National Pneumatic Company was installed on several streetcars in 1936. The wiper was operated by a small cylinder which contained a spring and a small valve in the piston. When compressed air was admitted into the cylinder, the piston would move along the cylinder. The spring inside the cylinder would be compressed during this stroke. When the piston reached the end of its travel, the valve on the piston face would touch a pin on the end of the cylinder. This action caused the valve to open. The resulting loss of air pressure allowed the spring to force the piston back to the other end of the cylinder where the piston valve was closed by another pin. In this fashion, the piston repeatedly reciprocated. The wiper blade was suspended at a single pivot and was connected to the piston by a lever. Every stroke of the piston, therefore, moved the

wiper blade across the windshield in an arc. (National Pneumatic Drawings of Windshield Wiper, 1936) The installation of air operated wipers on the Edmonton streetcars was a slow process because of their costs and the prevalent economic conditions.

By early 1940, the SRD was operating several motor and trolley buses. These vehicles all possessed some sort of automatic windshield wiper. On March 9, 1940, the secretary of the local street railway workers' union wrote to the Mayor and the City Commissioners requesting the installation of automatic windshield wipers on all streetcars. The secretary made the point that during snow and rain storms, the visibility was very poor from streetcars that were not equipped with wipers. This condition, it was attested, increased the risk of a serious accident since there were many motor vehicles and pedestrians on the streets at that time. (Letter to the Mayor and Commissioners from Secretary of Local 569 of the Amalgamated Association of Street and Electric Railway Employees of America, March 9, 1940)

In response to this request, the SRD began to equip most of its passenger streetcars with air operated windshield wipers which were manufactured by the Trico Wiper Company. These wipers were similar in construction and operation to the wipers described earlier. In some instances, where a streetcar had a widened windshield, the SRD installed a larger version of the wiper which moved two wiper blades across the windshield. (Letter to B. C. Electric Railway Co. Transportation Manager E. W. Arnott from SRD Superintendent T. Ferrier, December 5, 1941)

Besides windshield wipers, the trolley buses possessed radio interference suppressors which were placed in series with each trolley pole. The suppressors consisted of a metal housing which contained a large choke coil and a capacitor which were connected in parallel. The purpose

of the suppressor was to create a high series impedence which would prevent surplus electrical impulses from reaching the trolley wires where they would be "broadcast". If suppressors were not used, the spurious pulses reached the trolley wires. When this occurred, "static" noises were created. Radios in the vicinity of the trolley wires, therefore, could receive this static. (English Electric Co. Specification 4894/1, September 21, 1938, p. 17) The suppressor could also be applied to streetcars in order to achieve the same result. By the end of this period, most streetcars in operation in Edmonton had been fitted with an interference suppressor. One suppressor was placed on each streetcar. The suppressor was bolted to the running board a short distance in front of the trolley pole. (Photographs in the Author's Collection)

The SRD continued to refurbish and to rebuild its rolling stock when required. Two types of front vestibule modifications were introduced during this period on some of the St. Louis built streetcars as well as some of the big Preston streetcars. In order to provide the motorman with a better field of vision to the right, the SRD moved the front roller sign from the right-hand window to the letterboard above the centre window. It should be noted that the roller sign in this location was mounted so that the front glass was flush with the letterboard. The letterboard lenses, however, had to be moved. They were placed on either side of the roller sign. Since the letterboard curved away from the front, the lenses were mounted on short wooden tubes which enabled the lenses to point towards the front of the streetcar. Photographs indicate that twelve streetcars were modified in this fashion. They were: 32, 33, 34, 36, 38, 39, 45, 47, 52, 63, 70 and 78. (Photographs in Author's Collection)

A later version of this modification included the widening of the

centre window to increase the motorman's unobstructed field of vision. In this version of the modification, the two window posts were moved towards each side of the vestibule. Thirteen streetcars were modified in this fashion: 35, 41, 43, 44, 48, 57, 59, 65, 66, 71, 72, 73 and 79. (Photographs in Author's Collection) It should be noted that the two aforementioned modifications did not entail substantial rebuilding of the vestibule frames.

A modification to the red and ivory (cream) paint scheme took place during this period. The former practice of placing the streetcar's number in black between the letterboard lenses was dropped in favor of placing the numbers in gold or yellow near both edges of the dashes. This change took place as each streetcar was repainted. (Photographs in Author's Collection) The placement of the numbers on the dash can be seen in Plate 25. The vestibule modifications, as well as esthetic considerations, were probable reasons why the number placement was altered.

The interiors of the streetcars were also modified during this period. The use of Agasote and open bulkheads in streetcars 80 through 84 had made a noticeable improvement to heat circulation and heat retention. By 1936, Agasote was being used to replace the ceilings and the wainscoating on streetcars. In addition, the doors and the partitions in the rear bulkheads were removed to facilitate air circulation. (Letter to the City Commissioners from SRD Superintendent T. Ferrier, December 24, 1936, and Photographs of Streetcar Interiors in City of Edmonton Archives) An attempt was also made to increase the amount of heat that reached the motorman's position. An insulating material, probably wood shavings, was installed between the wainscoating and the exterior sheathing of the vestibule. In addition, a hot air duct was installed in the vestibule

from the Peter Smith heater. (Letter to the City Commissioners from SRD Superintendent T. Ferrier, December 24, 1936) The interior modifications also included the floors.

As early as 1928, Superintendent Cunningham had noted that the floors in several streetcars were worn to the extent that they required replacement. It had been found that fir was an unsatisfactory wood for the floors because it was a softwood and it wore away quickly. It had also been discovered that yellow pine, a denser softwood which had been used for the flooring in the St. Louis built streetcars, had lasted a much longer time. (Letter to D. Ackland & Son Ltd. from SRD Superintendent W. J. Cunningham, April 12, 1928)

As each streetcar underwent ceiling and bulkhead modification, the floor boards were replaced. The floor level in the rear vestibule was also raised so that it was level with the body floor. This arrangement prevented passengers from stumbling as they passed from the car body to the vestibule or from the vestibule to the car body. The emergency exit had to be reached by one or two small steps which were placed in a well around the area of the door. To prevent passengers from falling into the well, stanchions and wooden panels were placed on either side. (Photographs of Streetcar Interiors in City of Edmonton Archives)

In 1937, the SRD experimented with the use of roller bearing centre plates on two of their passenger streetcars. It should be recalled that the centre plate bearings then in use by the SRD were grease lubricated sleeve bearings. Big Preston streetcars 56 and 60 were selected to be fitted with roller bearing centre plates since the bolsters on these two units had been moved closer to the centre of their bodies. These streetcars, therefore, had greater body overhang than the other big Preston streetcars. This meant that the bodies of Numbers 56 and 60 would

swivel on their trucks more as they travelled through curves. The purpose of the roller bearing centre plates was to reduce friction between the bolster and the truck, which would enable the trucks to swivel easily. This ease in movement would reduce wear on the wheel flanges, thus prolonging their lives. In 1940 after three years in service, it was determined that the roller bearing centre plates had prolonged the lives of the wheel flanges on streetcars 56 and 60, thereby reducing maintenance costs. (Letter to SRD Superintendent T. Ferrier from SRD General Foreman A. J. Brass, June 21, 1940) Although the roller bearing centre plates were successful in reducing maintenance costs, the SRD did not install them on other streetcars. The high initial cost of the roller bearing centre plate assembly was probably greater than the resulting savings in maintenance.

During this period, the Ohio Brass headlights were removed from streetcars 80 through 84 and were replaced by the standard Crouse-Hinds type Z headlight. In addition, the route colors were painted on the back of the motorman's mirror. This did not pose a problem for route changes since these streetcars were continually assigned to the same route. It is probable that the route colors were placed on the mirror because the colored roller signs could not be seen easily during the day. (See Plate 31)

Equipment Disposal, 1938

During 1938, the City and the SRD decided to convert some routes from streetcar operation to trolley bus operation because of the deplorable track conditions along these routes. (CEAR, 1938, p. 9; see also Chapter III) At that time, 50 streetcars were required for daily service while the SRD possessed 77 operable units. (SRDMR, January-June, 1938)

The prospect of reduced streetcar operations enabled the SRD to retire two of its older units. Numbers 10 and 14, which were both in need of considerable painting and repair, were retired by August. (Photographs in Author's Collection, and Edmonton Bulletin, August 13, 1938, p. 9) It should be noted that Number 14 was in fair condition, while the vestibules of Number 10 were sagging badly. (Photographs in Author's Collection) In 1938, it appeared that an operational fleet of 75 streetcars would be sufficient in the future.

Passenger Equipment, 1941

In May, the City Librarian approached the SRD with a proposal to have retired streetcar Number 14 refurbished as a mobile library in order for the library to provide service to residents of outlying areas of Edmonton. The SRD agreed to undertake the necessary refurbishing work on streetcar Number 14 in order for it to be ready for service as a library car by September. (Letter to Librarian H. C. Gourlay from SRD Superintendent T. Ferrier, May 27, 1941) The "Library Car", as it was referred to, was not completed until early October. (Edmonton Journal, October 14, 1941, p. 13)

Several changes had been made to streetcar Number 14. All but four of the body windows on each side had been replaced by boards. The interior was outfitted with bookcases which were secured to the walls of either side. The seats were removed from the interior as well. Interior lighting was provided by the old system of three parallel strips of lamps which ran along the length of the body. Additional lamps were placed over the front and rear doors. (Photographs in Corness Collection) The exterior was painted blue between the base and the belt rail and ivory (cream) above the belt rail. The name "Edmonton Public Library"

was placed in black on the centre of each side a few inches (mm) above the belt rail. The belt rail itself was painted black. (Color Photographs in Corness Collection) The blue paint was similar to Pantone ink shade 292C while the ivory was similar to the ivory paint described earlier. (Color Photographs in Corness Collection, and Pantone Matching System Book, 1980)

Plate 33 (Provincial Archives of Alberta) shows the Library Car on the northern leg of the Calder Y sometime during 1946. (See also Chapter III) The bus next to the Library Car is Number 4 which became a library bus. It will be described in a subsequent chapter.

Passenger Equipment, 1946

In March 1943, streetcar Number 28 suffered severe damage as the result of a fire. (Photographs by E. M. Smith) This streetcar could not be placed back in service without extensive rebuilding to the interior and the roof. The ridership on the street railway had increased by such an extent during the Second World War that every serviceable passenger streetcar was required. In addition, the City was restricted by the war-time Federal Transit Controller on the number of new trolley and motor buses it could obtain. (CEAR, 1943, pp. 10-11) By late 1945, the SRD desperately needed equipment. In an attempt to ease the rolling stock shortage, the SRD undertook the reconstruction of streetcar Number 28. The old roof and sides were replaced. The new sashes and arched roof were fabricated so that they resembled the sashes and roofs of the big Preston streetcars. The front vestibule of Number 28 was modified so that the centre window was widened. In addition, the roller sign was mounted in the letterboard above the centre window. (Photograph by E. M. Smith) The interior seating had been destroyed by the fire

so replacement seats were taken from the unused observation car. It should be noted that the observation car had been equipped with wooden slat seats. (Photographs by E. M. Smith) The rebuilt streetcar was placed in service by April 1946. (Notations on Photographs by E. M. Smith)

Number 28 was the last streetcar to be extensively rebuilt by the SRD. In 1947, the ETS began to dispose of its streetcars when new motor and trolley buses arrived.

Equipment Disposal, 1947-1952

By October 1947, the ETS had received large shipments of both motor buses and trolley buses. (See Appendix I) The need for streetcars had declined. By the end of December, the ETS had retired four of its oldest streetcars: 3, 4, 5 and 6, that had been in use since 1908. (SRDMR, September-December, 1947, and Photographs in Corness Collection) These retired streetcars were subsequently stripped of: motors and electrical controls, trucks, air brake apparatus, seats, heaters and in some instances, the windows. The units were then offered for sale to individuals at varying prices for use outside the City. (Correspondence between ETS Assistant Superintendent D. L. MacDonald and Various Individuals, May 1948-October 1951)

The remaining streetcars were removed from service and were disposed of in the same manner as the system began to abandon its trackage. (See Appendix I, and Chapter III) With the termination of streetcar operations in September 1951, the ETS disposed of most of its remaining streetcars except for Numbers 80 through 84. These four streetcars were retained for possible resale as operating units. When no buyers were found for these units, they were later stripped and sold. In the case of streetcars 82 through 84, they were destroyed by the

ETS. (Photographs in City of Edmonton Archives; See Appendix I) Streetcar Number 1 was also retained complete for possible historical preservation. It was unfortunate, however, that Number 1 was stored out of doors where it was ravaged by the elements and by vandals. In addition, several streetcar bodies, including the wrecker car (Number 6) were used as storage sheds near the Cromdale car barns for several years. (Photographs by E. M. Smith)

The salvaged seats, heaters and windows were also sold to individuals, while the trucks, electrical equipment and air brake apparatus were sold for scrap. (Correspondence between ETS Assistant Superintendent D. L. MacDonald and Various Individuals, February 1950-June 1952)